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DEPARTMENT OF COMMERCE

UNITED STATES BUREAU OF MINES
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UNDERGROUND CHUTE GATES IN METAL MINES

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BY

CHAS. F. JACKSON AND JOHN B. KNAEBEL

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UNDERGROUND CHUTE GATES IN METAL MINES

By Chas. F. Jackson[2] and John B. Knaebel[3]

INTRODUCTION

This paper is one of a series dealing with special mining problems and forming part of a general study of mining methods and costs being conducted under direction of the Bureau of Mines. A considerable part of the material assembled and discussed in this paper has been gathered from articles on individual mines written by consulting engineers to the bureau who are engaged in active mine operation at the properties described, while other data have been taken from the technical press or gathered from personal observations.

OBJECT AND SCOPE OF PAPER

C. F. Jackson[4] has pointed out that underground transportation (tramming, haulage, and hoisting) absorbs an appreciable percentage of the total underground cost of most mines, averaging for different methods of mining 12.9 to 28.4 per cent of the total underground cost. In general the percentage of cost accounted for by transportation was shown to be highest for the low-cost mining methods.

In mining ore bodies of considerable vertical dimension, whether of the thin steeply dipping tabular type, in the form of large irregular masses, or in thick regular beds, gravity is generally utilized for moving the broken ore from the mining face either directly from the stope or through chutes, to points on the haulage levels. The ore is there loaded into cars which are hauled or trammed to the shaft or out through adits or tunnels to the surface.

The loading of the cars is in each case an important link in the movement of the ore. The loading time and labor required for this operation are often more, sometimes several times more, than that consumed in movement of the cars. The contrivances employed for controlling the flow of ore from stopes or chutes into the cars are here termed "chute gates" or "chute doors," but are often termed simply "chutes." Gates are also employed underground for controlling movement of broken ore or waste at main passes, underground crushers, skip pockets, and skip measuring pockets.

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1 The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is used "Reprinted U. S. Bureau of Mines Information Circular 6495."

2 Principal mining engineer, U. S. Bureau of Mines.

3 Assistant mining engineer, U. S. Bureau of Mines.

4 Jackson, C. F., Some Notes on Underground Transportation in Metal Mines; Inf. Cir. 6326, Bureau of Mines, 1930, 40 pp.

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Gates improperly designed and constructed or unsuited to the conditions are often the cause of much delay, wasted labor, and expense. There are a number of general types of chute gates each of which embraces several variations in detail of construction or method of operation; and the selection of that type of gate, construction detail, and method of control best suited to a given set of underground conditions is a matter of considerable importance. It may be the means of effecting appreciable savings in operating costs.

Observations in a large number of mines indicate that the possibility of considerable saving exists to-day in many mines through greater attention to this link in the operation.

In selecting the type of chute gate to install, such factors must be considered a physical character of ore or rock; size of chunks and their shape, hardness, moisture content, whether sticky or not; size of cars to be loaded; tonnage to be handled daily, and total tonnage to be handled through each gate during its life; and cost of installation. Consideration should be given to such operating features as ease and speed of manipulation, elimination of spillage of ore over the tracks or into the shaft, access to the chute for barring or for blasting down hang-ups, construction to avoid injury to chute gate in blasting and safety in operation.

The mistake most often observed in chute and gate construction is in the size of opening. The general tendency is to make the openings too small, so as to result in hung-up chutes which cause troublesome and costly delays in the working of the transportation system; particularly is this the case in handling lumpy ores. A small increase in size of chute opening often greatly facilitates and speeds up loading at small additional installation cost. Frequently chutes are made small to accommodate them to small cars. In some such instances it is suggested that larger cars should be installed in order to permit use of wider gates in newer sections of the mine.

The following classification of gates is more or less arbitrary but includes the principal types in common use and some rather unusual types, subdivisions of principal types being based upon construction details and method of manipulation.

1. Platform chutes:

    A. Chinaman chute:
        (a) With shrinkage stoping on drift timbers.
        (b) With shrinkage and box-hole pillars.
        (c) With grizzly.
    B. Scraper loading chutes.

2. Simple stop-board gates:
        (a) Cleated — boards between sides of chute.
        (b) Projecting — boards supported in iron brackets.

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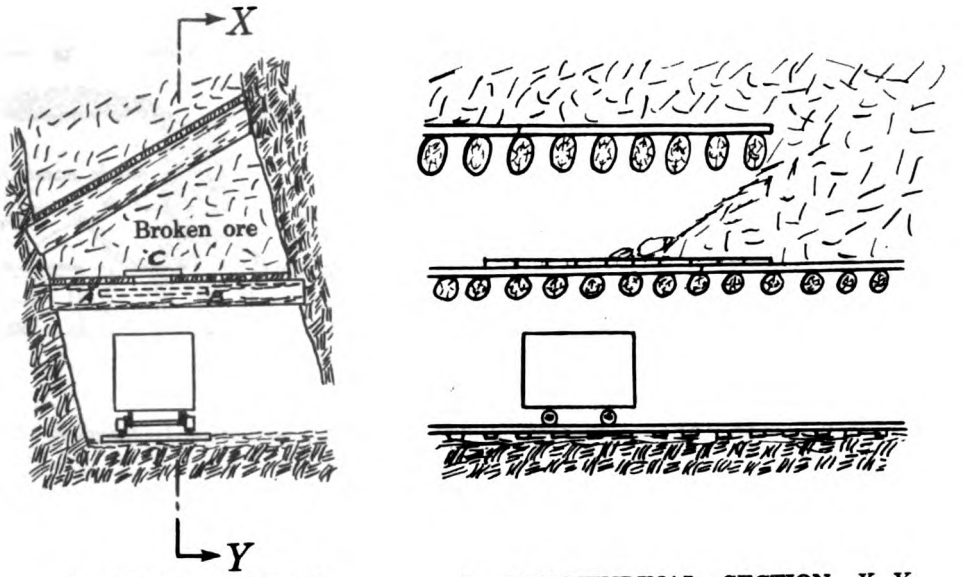

Figure 1.– Common type of Chinaman chute

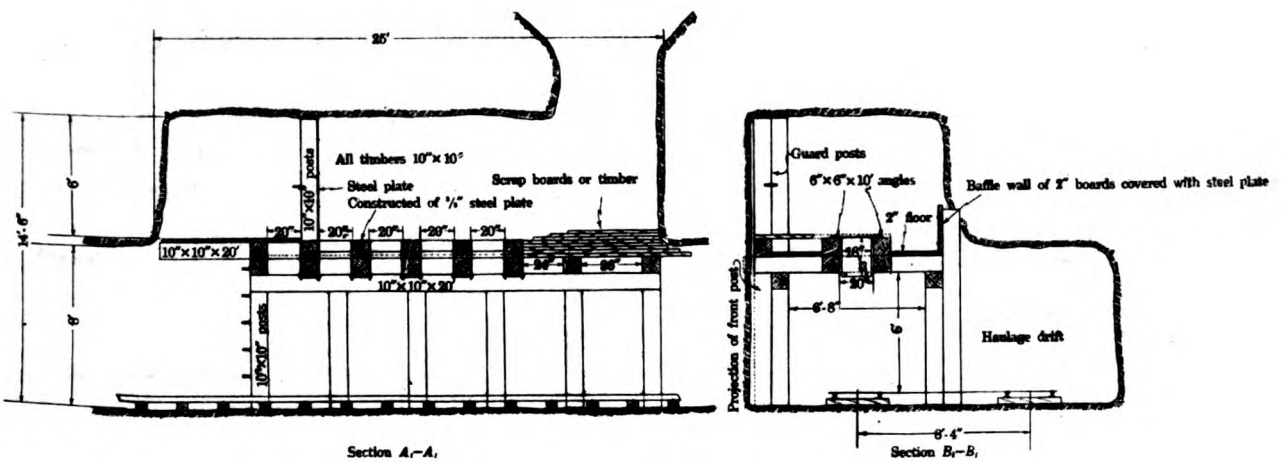

Figure 2.– Chinaman chutes and grizzly chamber, Burra-Burra mine

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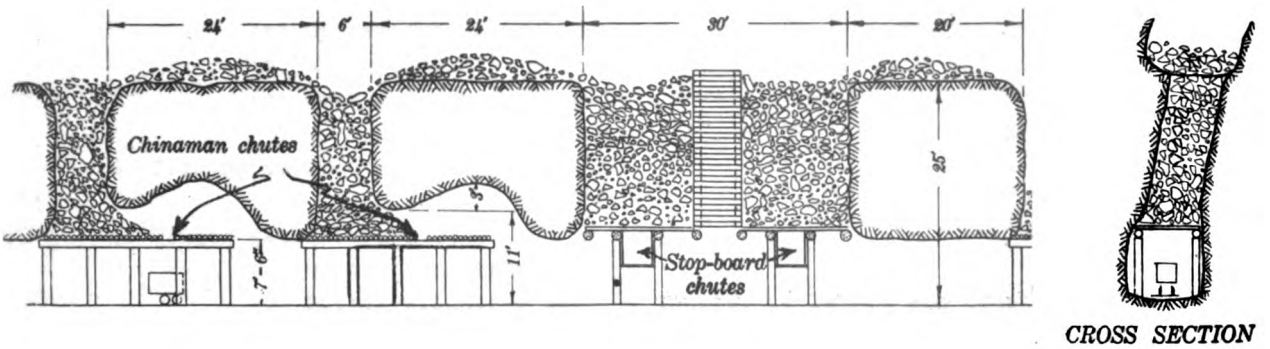

Figure 3.– Longitudinal elevation of boxhole stope, showing Chinaman chutes

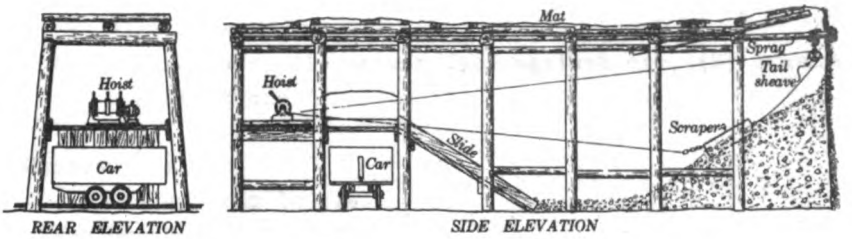

Figure 4.– Scraper loading platform chute

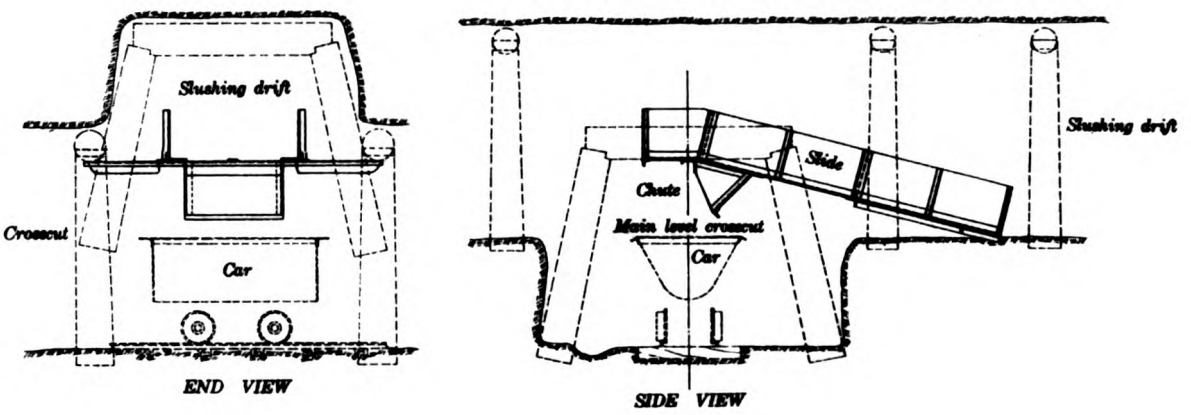

Figure 5.– Steel cantilever-type loading slide, for underground loading, Montreal mine

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3. Vertical overcut or "guillotine" type:
   (a) Operated by hand lever.
   (b) Air-operated.
   (c) Rack and pinion type.

4. Sliding undercut type.

5. Hinged gates or doors:
   (a) Hinged lip apron.
   (b) Bottom discharge door — toggle, or levers and counterweight.
   (c) Front discharge door — toggle, or levers and counterweight.

6. Butterfly type.

7. Arc-type gates:

   A. Overcut gates:
      (a) Flat door.
      (b) Curved door; (1) convex face against ore, (b) concave face against ore.

   B. Undercut gates:
      (a) Convex side to ore.
      (b) Concave side to ore.

8. Finger chute gates.

9. Curtain or flexible door type (particular attention is invited to this comparatively new type).

10. Auxiliary doors:
   (a) Baffle doors.
   (g) Stop logs.
   (c) Lip aprons.
   (d) Check logs and check hammers.

1. Platform Chutes

See Figures 1, 2, 3, 4, and 5. The platform chute, strictly speaking, is not a chute at all but is simply an opening between the timbers over the haulageway through which the muck is dropped, scraped, or shoveled into the mine cars. This type of loading device has the advantage of extreme simplicity, low cost, and ease of installation, and avoids troubles caused by the hanging-up of ore in the chute common to many of the types equipped with gates. Large bowlders, too big to handle in the cars, can be rolled to one side and there broken by sledging or blasting. An opportunity is afforded for some sorting out of

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waste also. However, except where power scrapers are employed, much of the ore must be handled by hand, and the tons per man employed in loading is low. When used with shrinkage stoping on drift timbers they are dangerous when the stope is almost empty since there is usually no protection over the loaders, or only light protection, and there is no cushion of broken rock lying on the timbers to take up the shock of possible falls from the stope, which if they occur will then crash through to the floor of the level.

Figure 1 is the common type of "Chinaman chute" employed in conncection with shrinkage stoping on timbers in numerous small mines working narrow veins. This type is employed at the Tintic Standard Mine in Utah for loading glory-hole waste into cars.[5] The board C (fig. 1) is removed for loading the ore in the car. Sometimes in addition to boards C, on top of the platform, short boards sliding on stringers between the caps and secured by cleats A and B are used to facilitate loading from below.

Figure 2 shows a type of platform or Chinaman chute with grizzlies employed at the Burra-Burra mine, Ducktown, Tenn.[6] The arrangement shown affords an opportunity to break up chunks of ore too large to be handled in the cars. At Ducktown the grizzly men spotted and loaded the cars under the "chute", the work being contracted at 4 to 7 cents per ton, 4 cents being the usual rate.

Figure 3 shows the Chinaman chute as installed for loading ore from shrinkage stopes over box-hole pillars at the Teck-Hughes Mine, Kirkland Lake, Ontario.[7] Here a great deal of the ore has to be pulled into the cars with a pick. The hole over the car is adjustable; and as the brow under which the ore flows wears away, this hole is moved back to the toe of the muck pile. Finger and toe accidents incidental to many forms of side chutes are rare. The rock brow in some cases has to be replaced by timber. At this mine, blockholing is not often necessary and is rarely practiced. The arrangement of the chutes is ideal for sand blasting, and it is almost impossible to damage the timbering even when the blasts are relatively heavy.

Figure 4 shows a type of platform chute employed for loading cars with power scrapers in top-slice mining on the Mesabi iron range,[8] and Figure 5 a similar type employed at the Monreal mine, Wisconsin, for loading ore into cars on the main haulage level.[9] As is shown clearly in the illustrations, the scrapers pull the ore up a sloping platform or slide and drop it through an opening into the cars.

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5 Wade, James W., Mining Methods and Costs at Tintic Standard Mine, Tintic District, Utah: Inf. Cir. 6360, Bureau of Mines, 1930 21 pp.

6 McNaughton, C. H., Mining Methods of the Tennessee Copper Company, Ducktown, Tenn: Inf. Cir. 6149, Bureau of Mines, 1929, p. 7 and fig. 6.

Jackson, C. F., Some Notes on Underground Transportation: Inf. Cir. 6326, Bureau of Mines, 1930, p. 18.

7 Henry, R. J., Mining Methods and Costs at the Teck-Hughes Gold Mines, Ltd., Kirkland Lake, Ontario: Inf. Cir. 6322, Bureau of Mines, 1930, 12 pp.

8 Jackson, Chas. F., Mining by the Top-Slicing Method, with Some Notes on Sublevel Caving: Inf. Cir. 6410, Bureau o Mines, 1931, 51 pp.

9 Schaus, O. M., Mining Methods and Costs at the Montreal Mine, Montreal, Wis.: Inf. Cir. 6369, Bureau of Mines, 1930, 29 pp.

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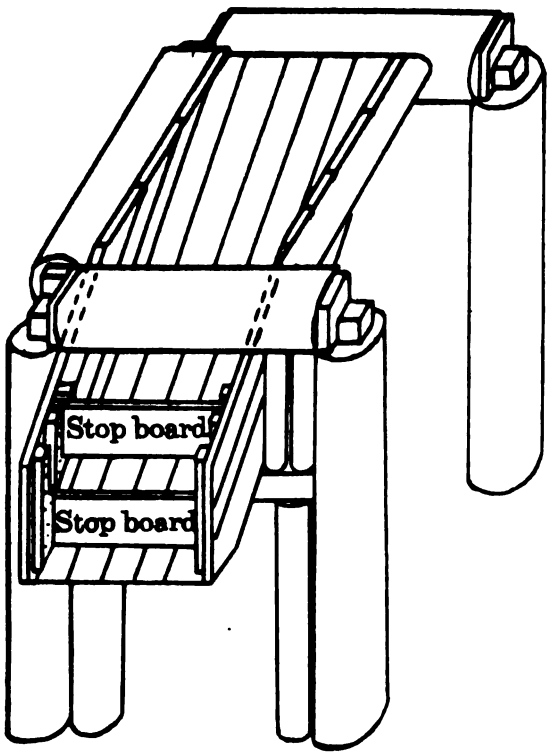

Figure 6.—Simple cleated stop-board chute

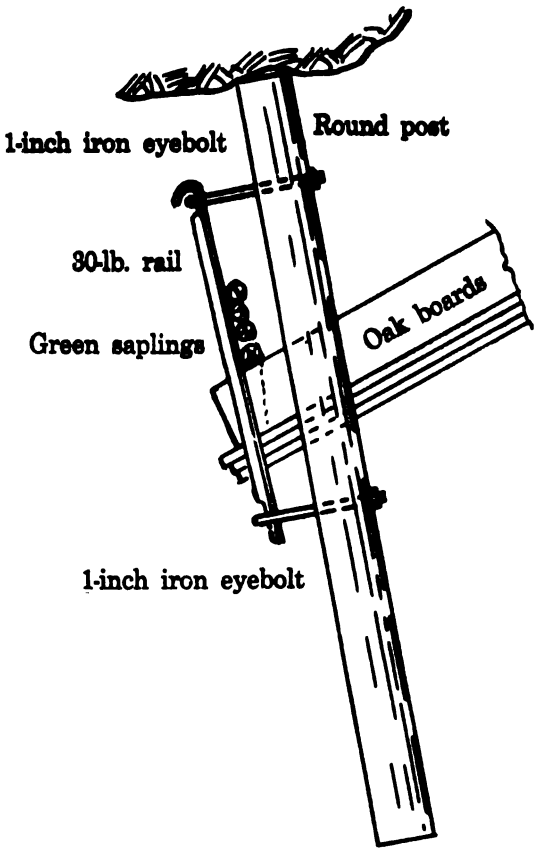

Figure 7a.—Bracketed stop gate, Ahmeek mine

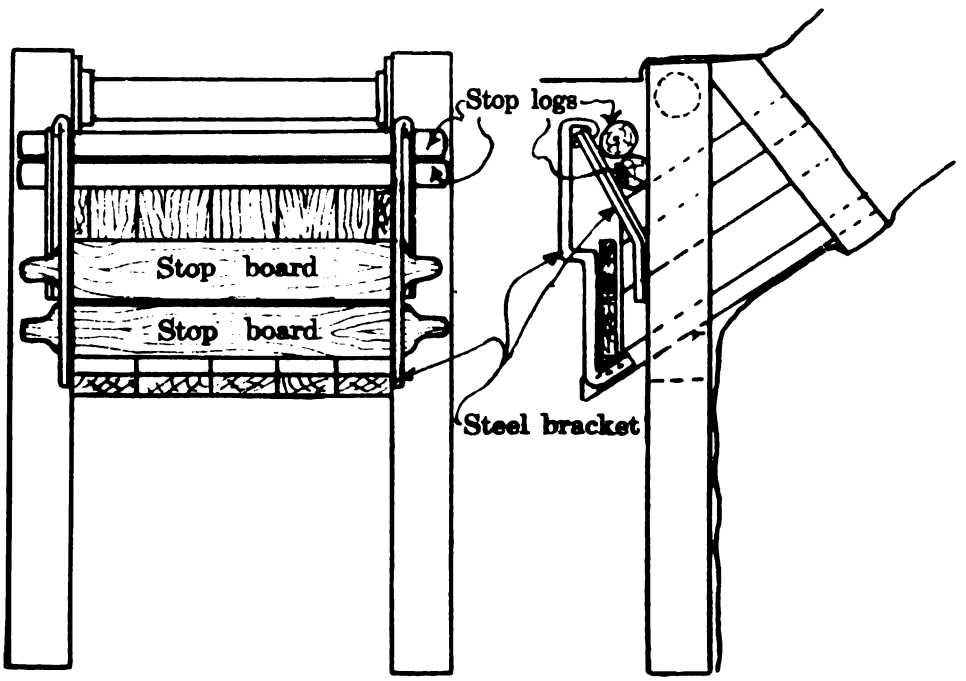

Figure 7b.—Stop-board chute with steel brackets

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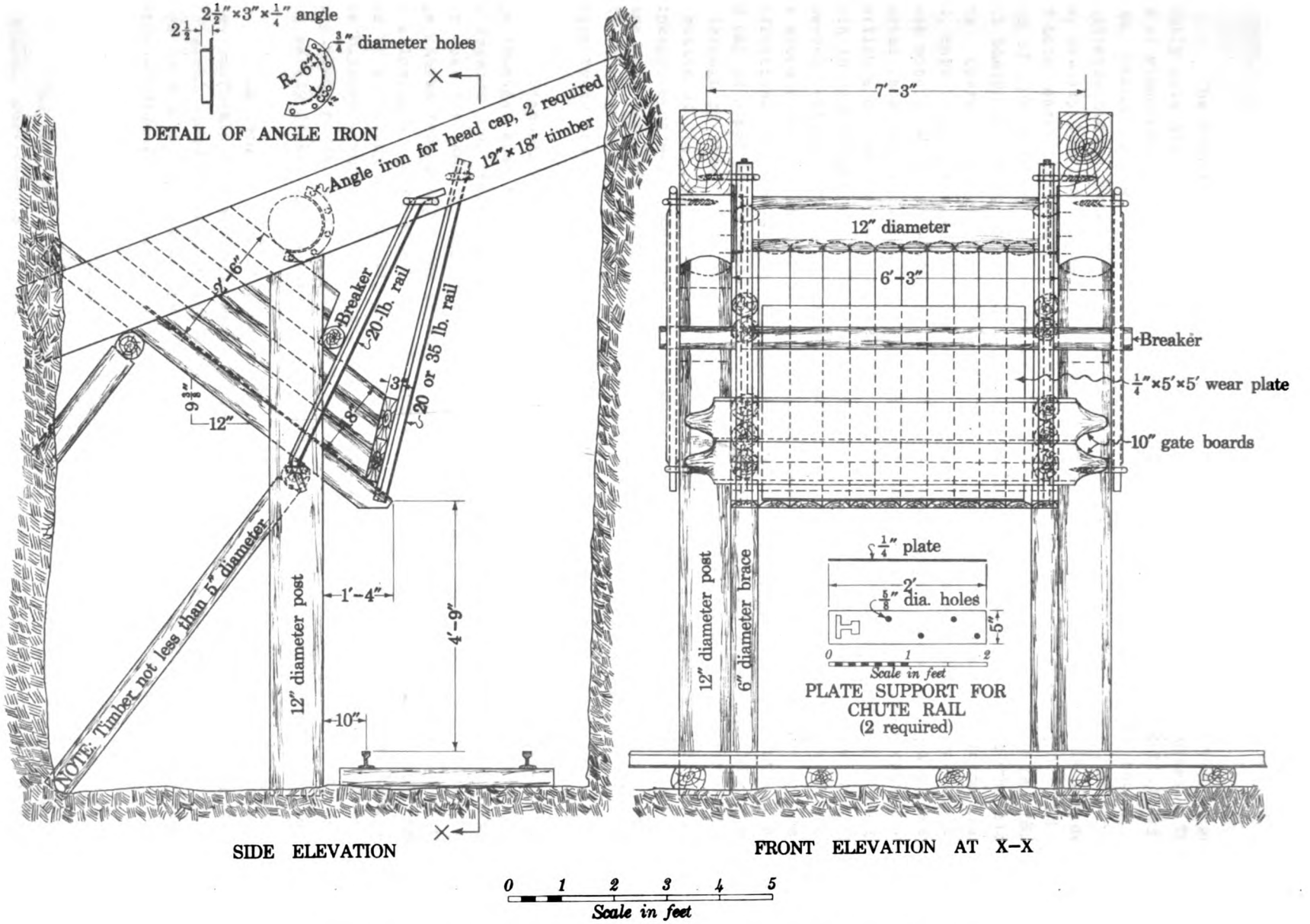

Figure 8.—Standard stop-board chute gate, Hollinger Consolidated Gold Mines, Ltd.

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2. Simple Stop-Board Gates

The stop-board chute gate is one of the simplest and cheapest types in use, and is probably more widely employed than any other type, especially in small mines. The cleated form of stop-board door is composed of one, two, or three boards sliding vertically, or nearly so, behind cleats secured on the inside of the side boards of the chute. Figure 6 illustrates such a gate. In drawing the chute the boards are pried up one (or two) at a time, usually leaving one down to stop any rush of ore. The upper boards are designed to hold back coarse chunks and the bottom one to regulate the drawing of the ore and to cut off a run of fine material. Other forms of stop-board are shown in Figures 7A, 7B, and 8 in which boards or poles are supported on iron brackets and project beyond the sides of the chute. Operation is similar to that of cleated chutes except that the boards are raised by hand, bars being generally unnecessary. Figure 7A shows a very simple type employed at the Ahmeek mine in Michigan. The use of auxiliary stop logs to check the rush of heavy, coarse material is shown in Figure 7B. The stop logs are designed to hold back chunks of ore. By inserting a bar over or between them the ore column may be worked down while the stop boards remain in the closed position. Figure 8 shows another chute gate of the same type, which possesses certain details of design adopted after many years of experience at the Hollinger mine where shrinkage stoping is employed and coarse rock has to be handled. This gate with modifications in details of construction is common throughout northern Ontario mines. The head cap is supported in a steel collar and can be quickly replaced if broken by blasting or cut through by sharp rock, as happens very frequently. Note also the method of supporting the bottom of the T-rail brackets. Stop-boarded chutes are widely employed at mines using shrinkage, square-set, cut-and-fill, various open-stope methods, and even caving methods of mining, and are best suited to use with methods requiring a large number of closely spaced chutes through each of which only a relatively small tonnage is to be handled, and more expensive types are not warranted and where rapid drawing is not essential.

Stop-board chutes lose the advantage derived from simplicity and cheapness when large tonnages must be handled through them, or when the broken ore is very hard and lumpy. Then repairs and replacements are expensive due to the frequent delays incurred and high labor cost for repairs, though cost of material may be small. Another disadvantage is that large chunks frequently lodge in the mouth of the chute and prevent dropping of the boards, thus allowing a run of fines to occur and spill over the track. This trouble can be minimized by providing a light lip apron to hold back the fines. Where chutes hang up and have to be blasted frequently, one board may be easily removed from this type of gate to facilitate pushing powder up on a pole, an advantage which is offset to some extent by the boards being easily broken by the blast so as to permit a rush of ore to bury the track.

In general, the stop-board gate is best suited to conditions where the ore is rather uniformly fine and dry, where large tonnages are not handled through each chute, and where great speed of loading is not of prime importance. In very heavy ground stop-board chutes have a decided advantage over the steel door types in that the gate boards may be readily altered when moving ground causes distortion of the chute timbering.

3. Vertical Overcut or Guillotine Type Gates

The vertical overcut or guillotine type of gate is often employed underground in ore mines, particularly in main ore passes, with storage and measuring pockets, and in connection with other more or less permanent or long-life installations. They are especially

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adapted to handling fine or medium size ore and waste, but when employed with lumpy ore, chunks lodging at the chute mouth are apt to prevent closing of the door. Spillage of fines under the door may be prevented by employing a lip board or apron on the end of the chute.

Gates of this type are usually heavy and are often made up of structural steel covered with steel plates or of wood sheathed with steel. Since any warping of the door or springing of the frame will cause them to bind and thus prevent operation, they must be carefully installed and rigidly supported. They would not be suitable therefore in bad ground where crushing and settlement are going on.

Rapid loading of ore is possible with this gate. As with other types of gates they should be proportioned in width, height, and weight to suit the class of material handled.

Since they are usually heavy, the gates are commonly actuated by means of air jacks or by rack and pinion, and since they are most often installed to handle comparatively large tonnages the expense of such operating mechanism is warranted. However, they are sometimes installed to handle small tonnages, in which event they may be operated by hand levers. (Figs. 9 and 10.) Figures 9 and 10 also show auxiliary lip aprons to prevent spillage of fine ore and to direct the ore into car or skip, as the case may be. A gate controlled from the side of the chute by a simple lever pivoted on a post of the chute-set and bearing against a pin in the center of the door was used at Angel's Camp[10] and other places on the Mother Lode (fig. 11). A type employed at the Kimberley diamond mines[11] has a lever pivoting on the cap in the back of the drift and operated from the side of the car opposite the chute, and is used in conjunction with a counterweighted hinged lip-apron (fig. 12). At Flat River in southeast Missouri, steel chutes are fitted with hinged aprons attached to shafts which are turned from the side of the chute by a crank. A vertical guillotine door is connected like a counterweight to the apron by means of a rope and pulley arrangement. As the apron is lowered by turning the crank (not shown in illustration) the door is raised; and as the lip is raised the door drops back by gravity. Chunks lodged under the door may be pried loose without danger of overflowing the car, since the chute mouth is closed by the apron[12] (fig. 13).

The chief application of the vertical overcut gate in present practice is on skip-loading pockets and haulage level or surface bins. Where large volumes of ore are handled, the chutes are wide and the gates are operated by air lifts (in some cases by hydraulic lifts) or less often by rack and pinion mechanisms. Figures 14, 14A and 37 show typical installations of the air-operated type. Action is positive in both directions.

A hand rack and pinion gate at Cortez, Nev., is shown in Figure 10. Under certain conditions this type seems to work better than others. In conjunction with measuring hoppers loading can be accomplished very rapidly, and the expense of air connections and power are eliminated.

Rack and pinion gates are used for loading cars from stopes at Grass Valley, Calif., and at the Argonaut and other mines along the Mother Lode. Where a few chutes must

10 Engineering and Mining Journal, Gate for Ore Chute: Vol. 90, No. 2, July 9, 1910, p. 61.

11 Engineering and Mining Journal, A Steel and Timber Ore Chute Gate: Vol. 92, No. 3, July 15, 1911, p. 104.

12 Engineering and Mining Journal, Counterbalanced Gate and Chute Stop for Underground Ore Pocket: Vol. 104, No. 26, p. 1129, December 29, 1917.

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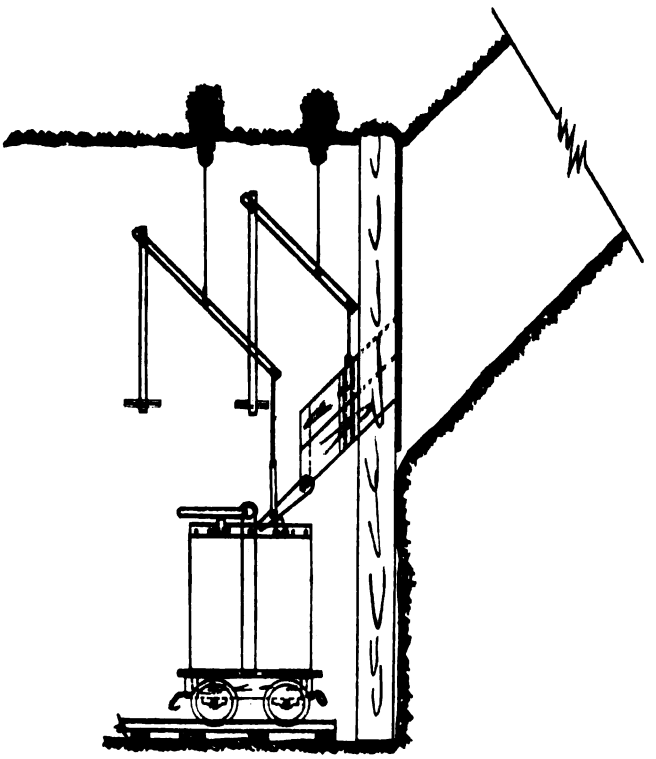

Figure 9.—Hand-operated guillotine-type gate

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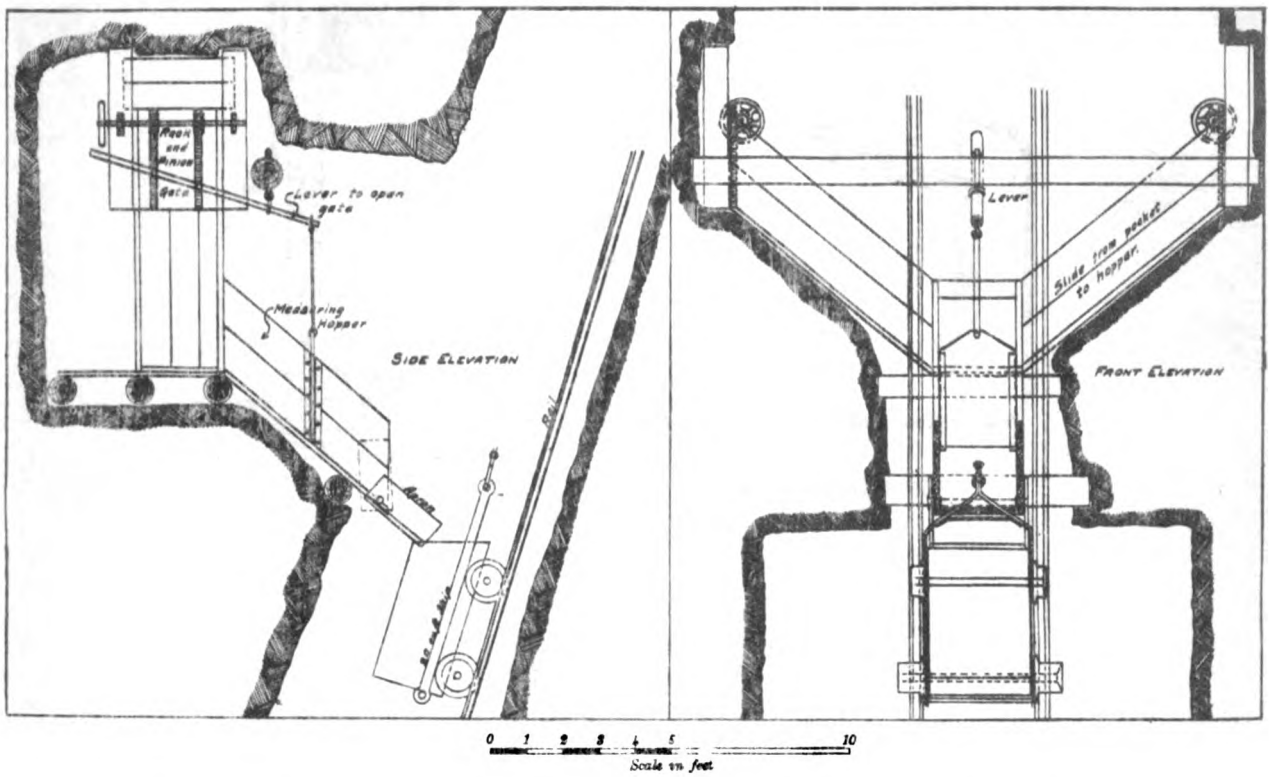

Figure 10.— Hand-operated guillotine-type gate with auxiliary lip apron, Cortez, Nevada

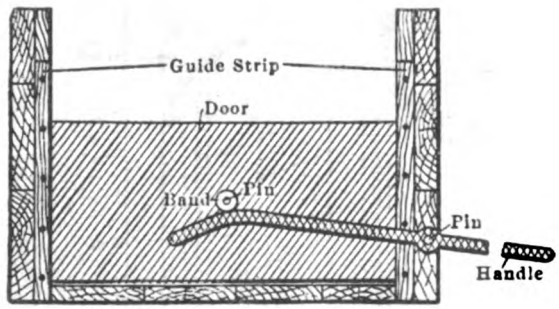

Figure 11.— Hand-operated guillotine-type chute gate

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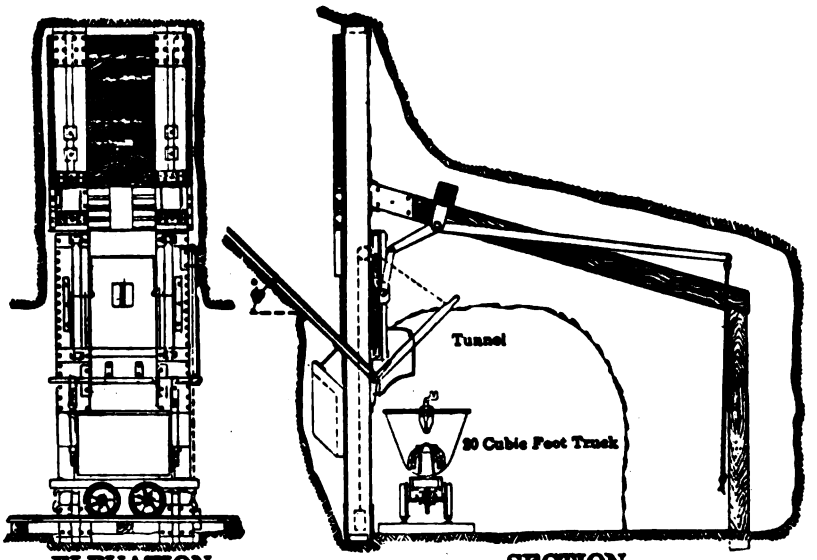

Figure 12.— Chute gate used at Kimberley diamond mines

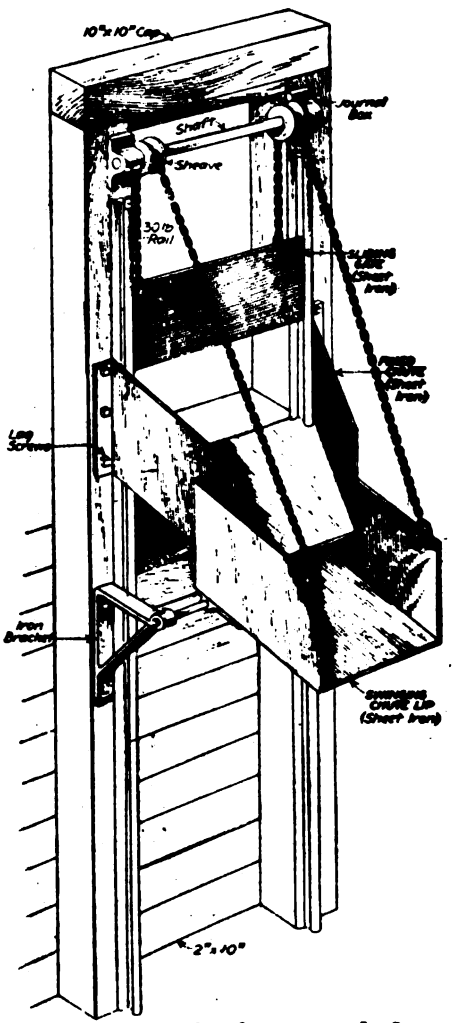

Figure 13.— Detail of counterbalanced guillotine-type chute gate and spout

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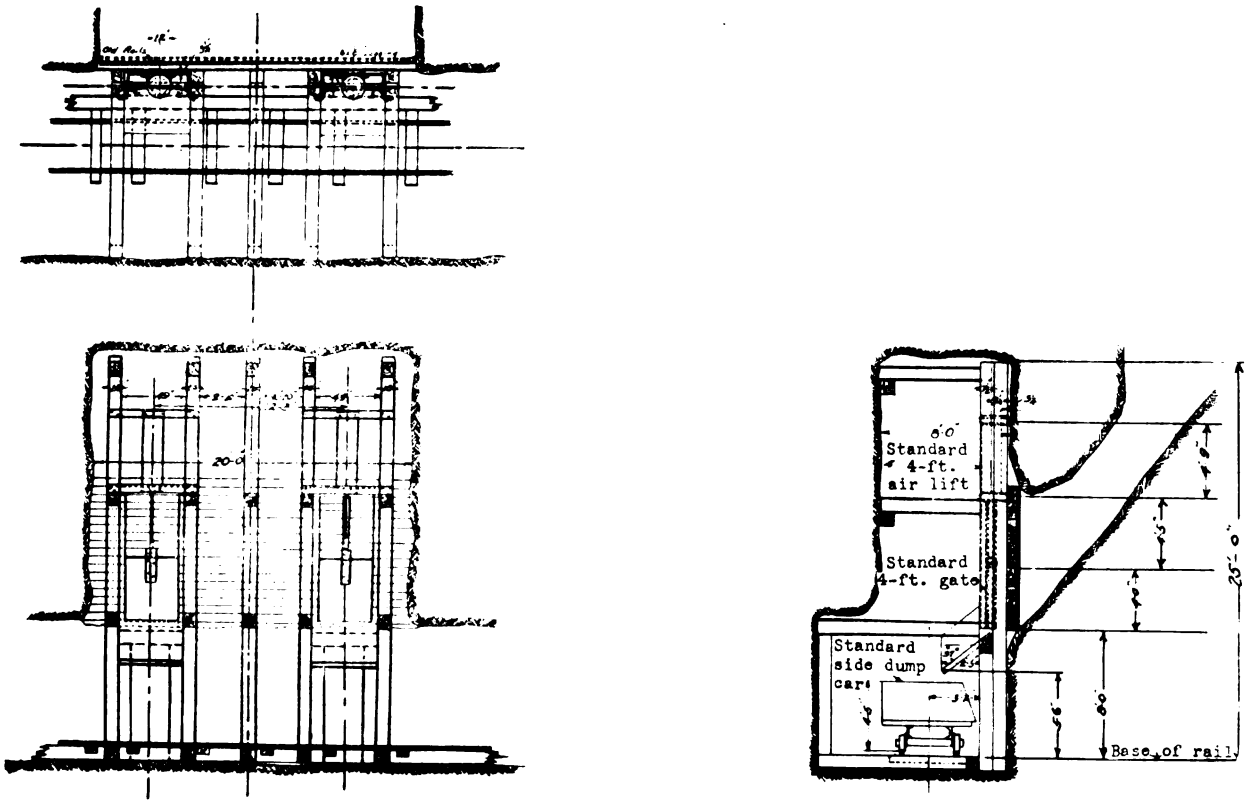
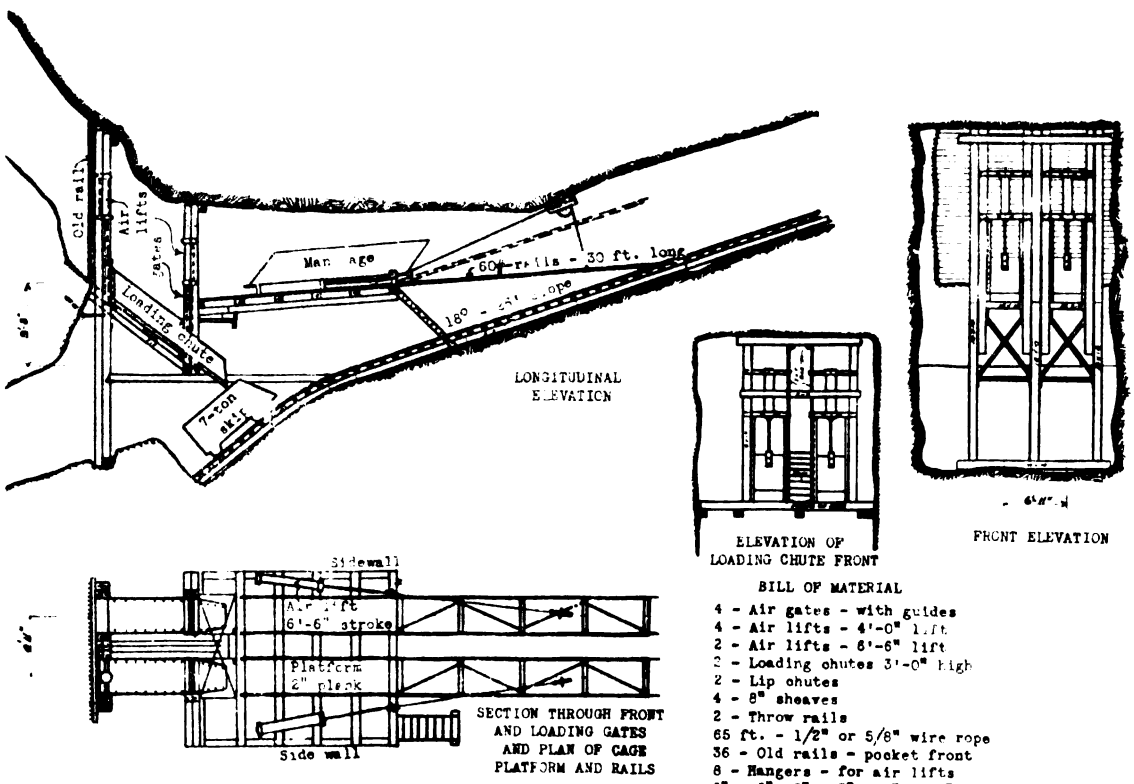


Figure 14a.—Standard fron for underground ore pockets



BILL OF MATERIAL

4 - Air gates - with guides
4 - Air lifts - 4'-0" lift
2 - Air lifts - 6'-6" lift
2 - Loading chutes 3'-0" high
2 - Lip chutes
4 - 8" sheaves
2 - Throw rails
65 ft. - 1/2" or 5/8" wire rope
36 - Old rails - pocket front
8 - Hangers - for air lifts
6" x 6", 8" x 8", 10" x 10" timber
plank for platforms

Figure 14.- Air-operated guillotine-type gates on ore pocket, Mineville, N. Y.

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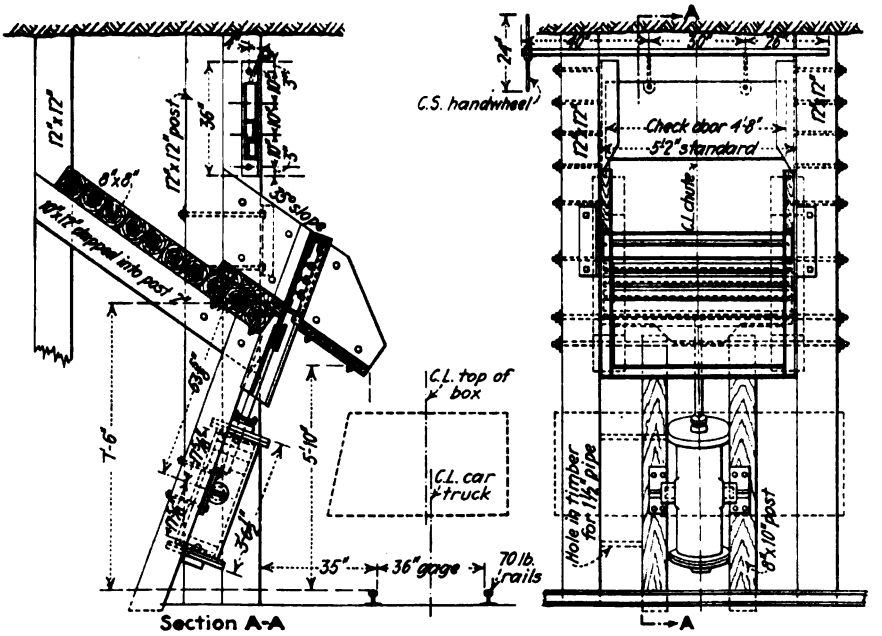

Figure 15.–Sliding undercut gate

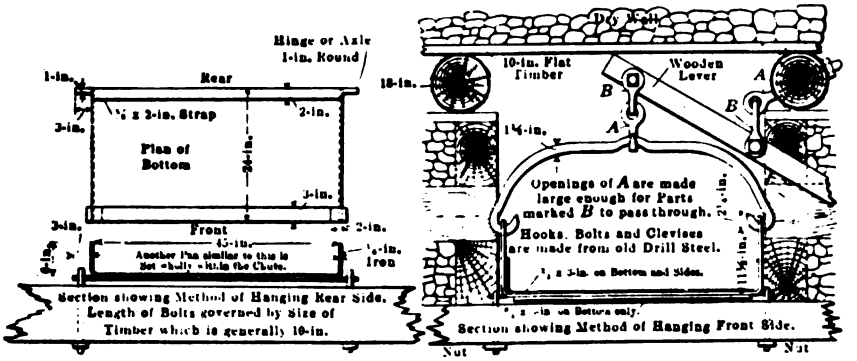

Figure 16.–Baltic gate; hinged lip-apron type

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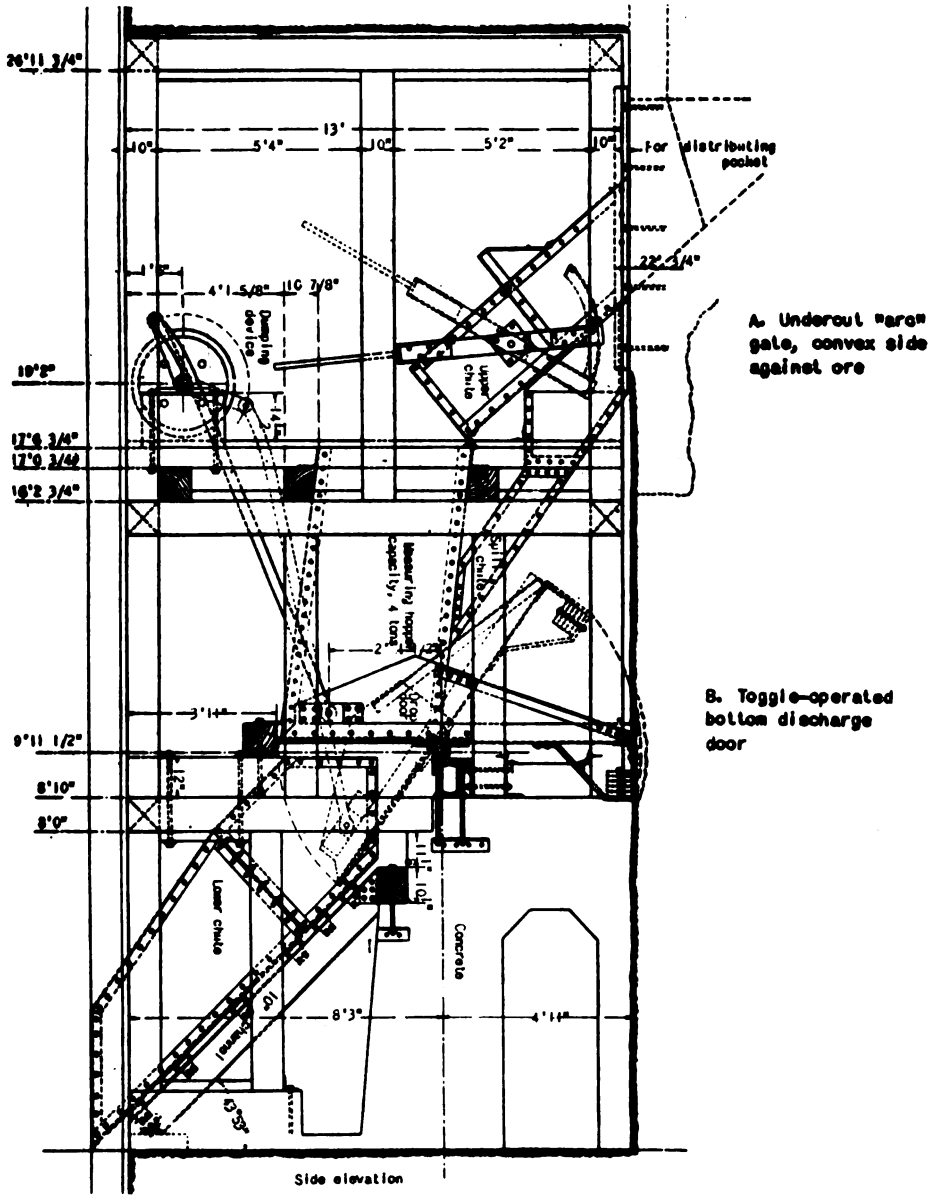

Figure 17.—Skip pocket, Guadalupe shaft, Pilares mine

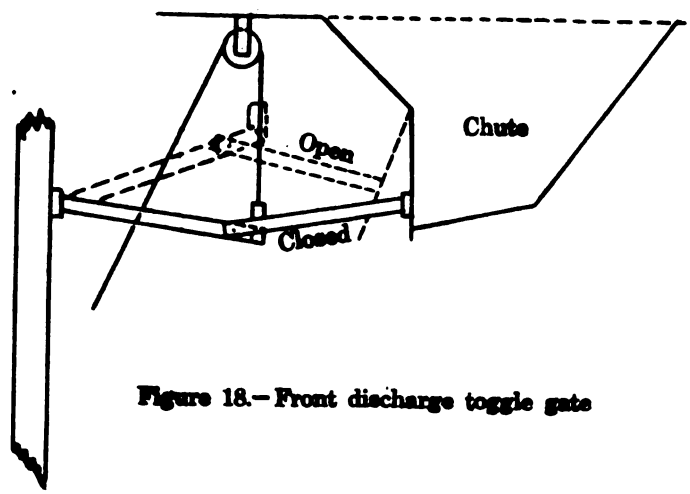

Figure 18.—Front discharge toggle gate

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serve a stope for a long period under conditions of moderate output, such gates may be cheaper to use than stop-board types. They are quite easy to install, are simple and safe to operate, and may be transferred to new locations when the stope is finished.

4. Sliding Undercut Gates

Undercut gates of the sliding type are very seldom used. They are similar in design to overcut gates, but operate from below rather than from above. A flat steel door, moving in guides either vertically or in a direction normal to the chute bottom, is actuated by a system of levers or by air cylinders (fig. 15).

Such gates are not limited in application to the handling of fine material, since they cut upward through the stream of ore and effectually check the flow of fines. That they are so seldom employed is due to practical rather than theoretical disadvantages, outstanding among which is a tendency for fine material to work into the guides. Jamming of the gate from this cause is a source of much annoyance and delay, and is doubtless chiefly responsible for the unpopularity of undercut sliding gates. Where used, they are now largely confined to loading pockets at mines where the ore is relatively coarse. As in the case of overcut sliding gates, it is essential that doors and guides be true and in perfect alignment or the door will jam and fail to operate.

5. Hinged Gates or Doors

Hinged gates or doors may be classified into three groups, depending upon the location of the discharge. Thus we have (a) hinged lip aprons, (b) bottom discharge doors, (c) front discharge doors.

The Baltic gate (fig. 16) long employed at the Baltic and Champion mines in Michigan, exemplifies the lip-apron type. This gate is operated from the side by a lever or long sweep attached to a bail connected to the sides of the apron. It was formerly used to draw ore from circular mill holes built up with dry walls through the filling in cut-and-fill stoping, and since the mill holes were alternately used for ore passes and manways, one of the main advantages lies in the construction of the gate which lends itself to easy set-up and transfer from one chute to the next. Its use has continued on timbered chutes in cut-and-fill stopes. In loading, the apron rests on the car, thus reducing spillage to a minimum. Nearly all other forms of lip aprons are used as auxiliaries with other types of gates. In this field they find application as a means of stopping runs of fine material (especially with overcut gates where chunks may prevent closing); as a sort of chute extension, and as a means of giving added clearance in haulageways and shafts, by pulling up when not in use. Figures 9, 10, 12, and 13 show lip aprons used in conjunction with other types of gates.

Bottom discharge hinged gates or doors are sometimes used on loading pockets and surface bins. They may be operated by a simple system of levers, by air-jacks, or by a toggle arrangement. In Figure 17 at B is shown a toggle-operated bottom-discharge skip-loading door at Pilares. The opening of this door is facilitated by the weight of the ore. No difficulty is encountered in closing it tightly, since after dumping, the measuring pocket is empty and the closed upper door keeps it so. One man can perform all the loading operations from the platform above the hopper. The bottom discharge type of door is particularly adapted for use with sticky ore which would build up on the sides and bottom of the chute mouth in pockets having the discharge opening in front.

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Front discharge doors are hung from the top, and the ore is discharged through the front of the chute or hopper. They are operated by air jacks or by toggles. Figure 18 is a sketch of a toggle-operated gate[13] of this type that was designed for use on ore bins at Mineville, N. Y. The construction is simple and the gate could be readily installed underground. The weight of the toggle bars should be sufficient to close the gate.

This type of gate is perhaps the one most commonly employed for loading skips from measuring pockets where the ore is hard and dry (fig. 19).

6.- Butterfly Type of Gate

A novel type of gate originating in South Africa and successfully used in Italy is illustrated in Figure 20. To open it the stop pin shown in the drawing is withdrawn, and the door swings outward due to the pressure of the material behind it. Flow of the material holds the door open at about the position indicated by dotted lines in the illustration. When the car is nearly full, the loader simply knocks the lower edge of the door upward until the upper edge drops somewhat below the level of the axis, when the pressure of the flowing ore against the back of the gate swings it shut against the pin (which has meanwhile been replaced).

This gate is extensively used in some European mines, for small chutes where the size of the lumps will pass under the revolving plate. It acts quickly and can be operated with little exertion. Where it can be applied, it has the advantages of simplicity and relatively small cost, as well as ease and safety of operation.

A similar type of gate has been employed in the Lake Superior iron district for loading silicious iron ore.

7.- Arc Type Gates

Arc gates are divided broadly into two classes: overcut and undercut. Overcut gates are raised above the chute bottom to allow passage of muck under the bottom edge and must cut downward through the ore stream in closing. Undercut gates are lowered to discharge the chute, and on closing they cut off the flow of material by cutting upward from below. When the radius of curvature of the gate face and the radius of its rotation are the same, the only resistance to opening is friction between the muck and the moving gate.

A.- Overcut Types. Overcut-arc gates in general have the same disadvantages as stop-board and vertical overcut gates. They are most satisfactory on fine or medium sized dry material. Chunks may lodge beneath the door and permit a rush of fines; or if the ore is sticky, fines may build up under one or both ends and prevent quick closing.

(a) The flat door type of gate shown in Figures 21 and 22 is not, strictly speaking, an arc gate, because the door is not curved. However, since it moves through an arc about a center as do the standard arc gates, and operates on the same principal, it is included with arc gates. This type of gate is used extensively in some of the southwestern copper mines; it is cheaply made and installed, easy to manipulate, and is best adapted to handling uniformly fine material. It is sometimes employed in combination with other types

13 Engineering and Mining Journal, Toggle-Joint Gate: Vol. 88, No. 11, September 11, 1909, p. 526.

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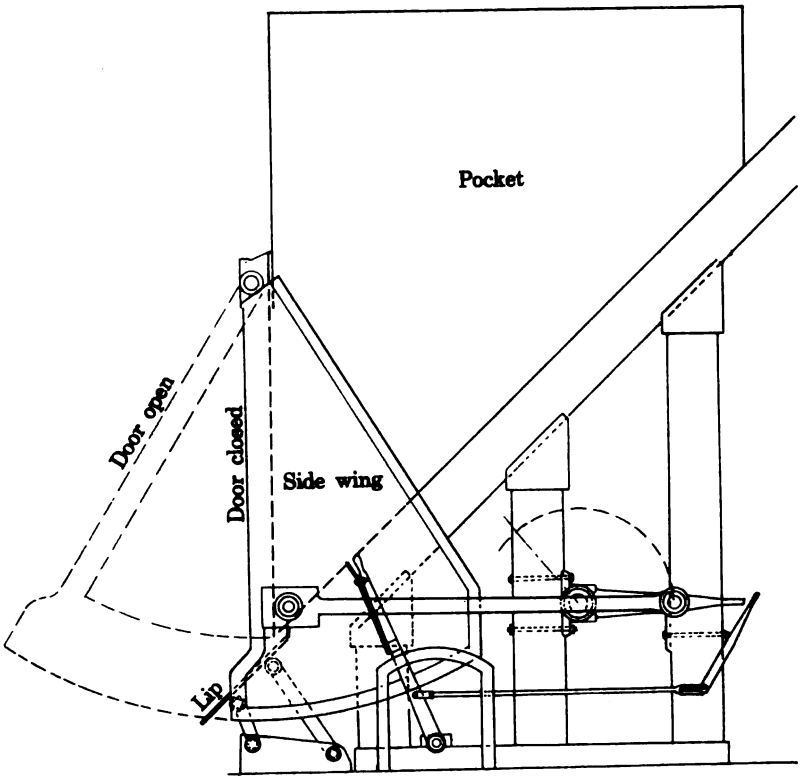

Figure 19.—Front-discharge gate for loading skip from measuring pocket

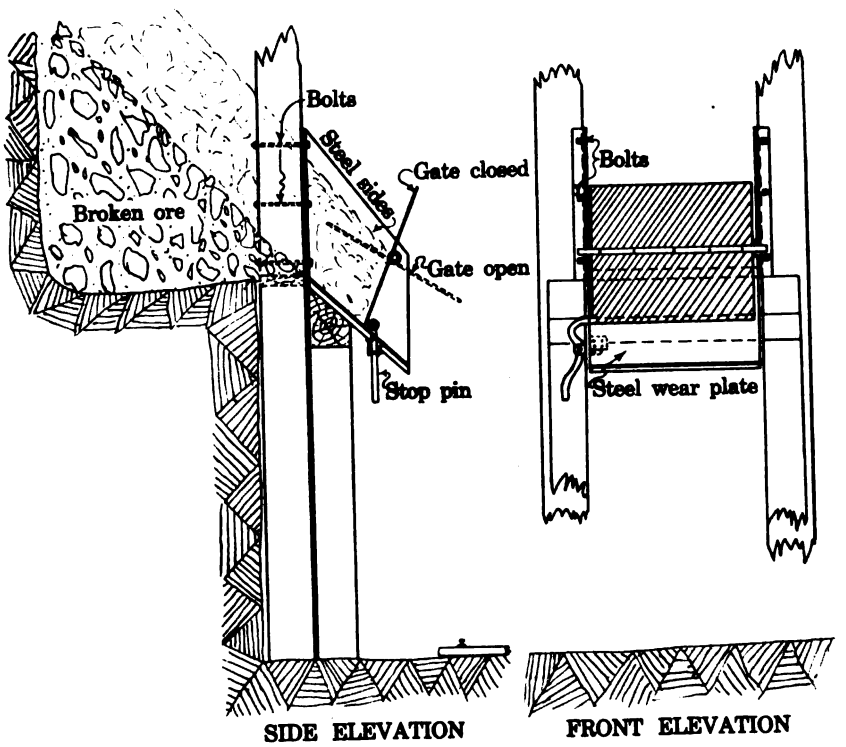

Figure 20.—Butterfly-type chute gate, used in Italy

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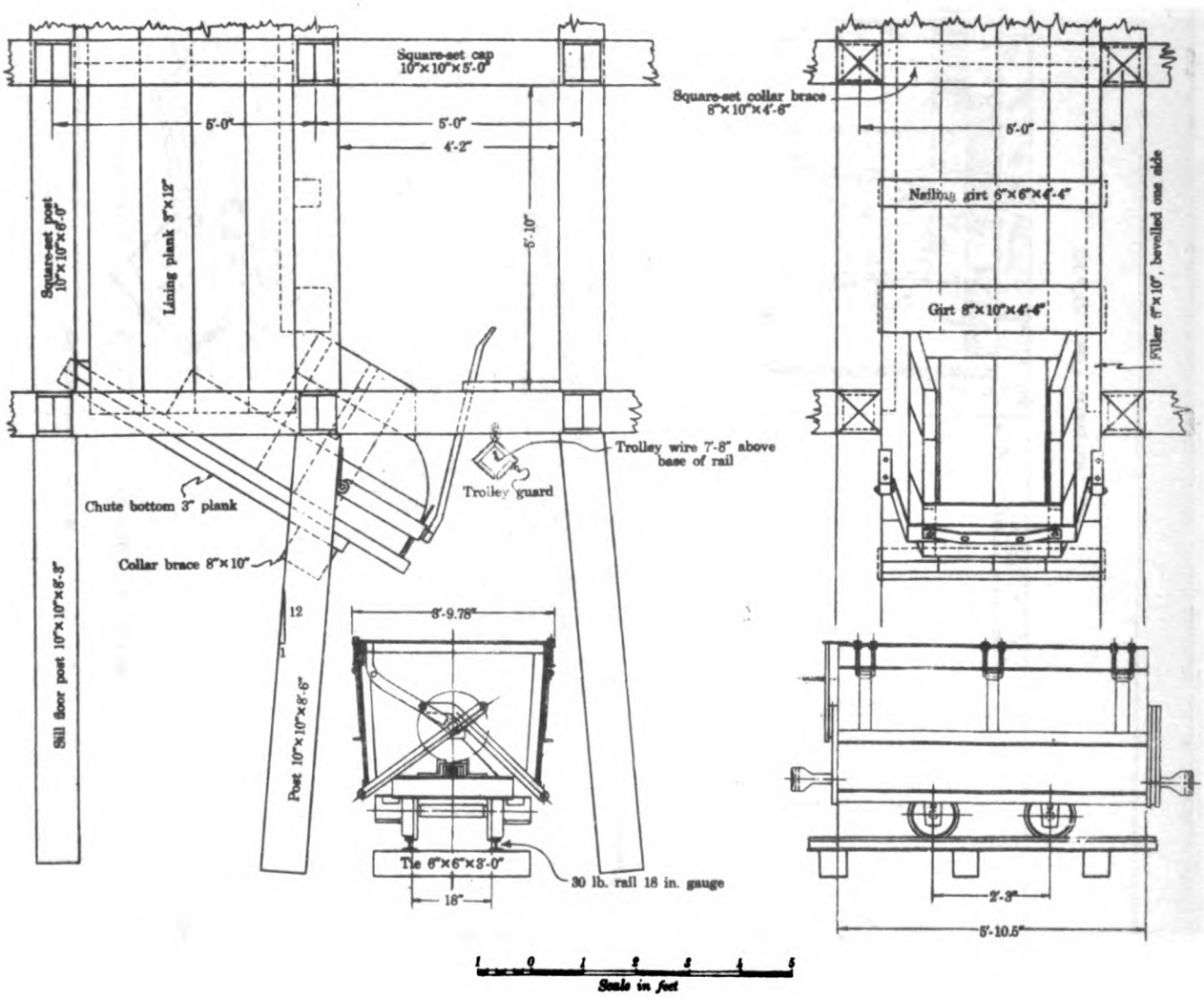

Figure 21.– Overcut-arc gate, flat-door type, Magma mine

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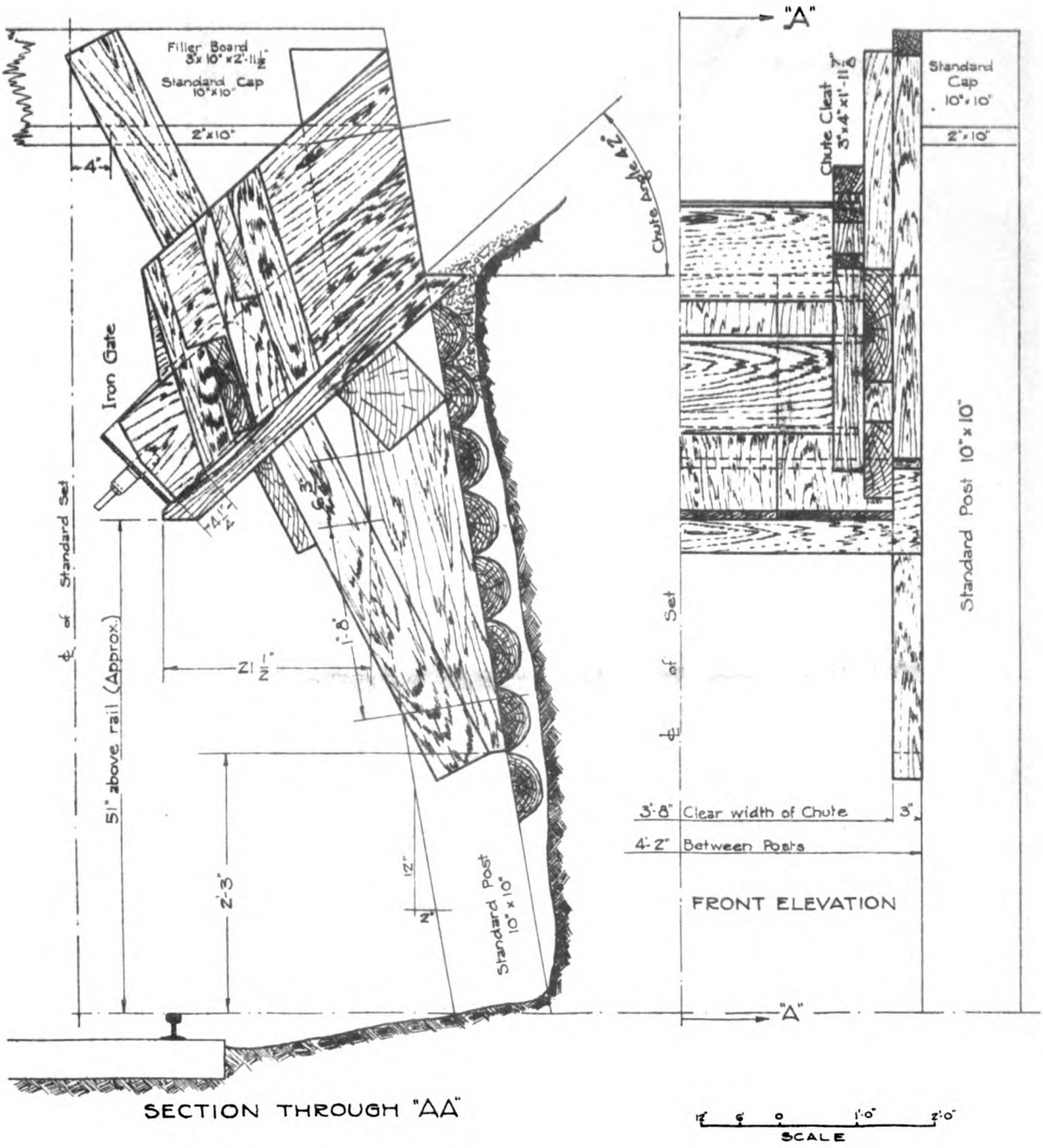

Figure 22.– Flat-door, overcut-arc gate combined with stop-board gate

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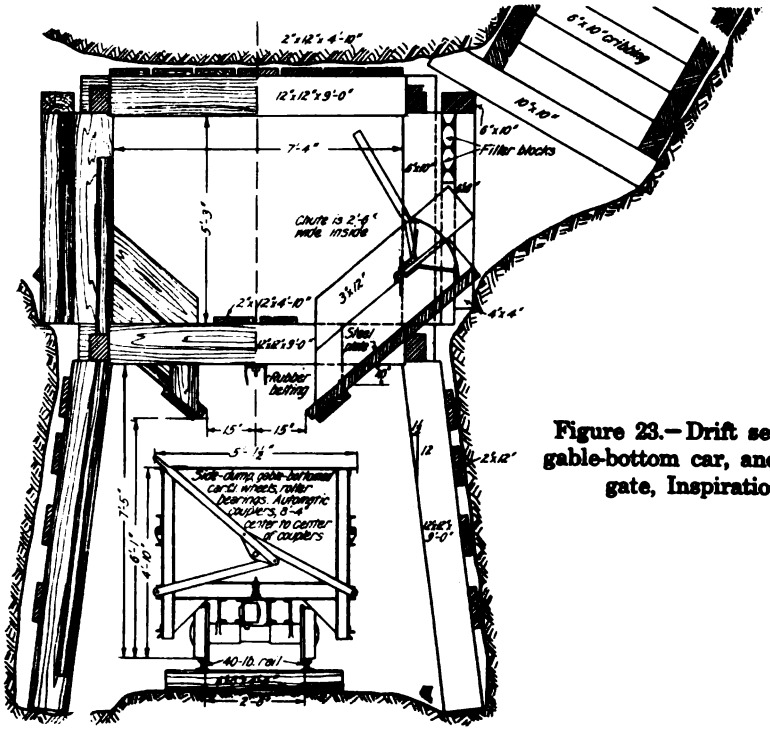

Figure 23.—Drift set, pony set, gable-bottom car, and overcut-arc gate, Inspiration mine

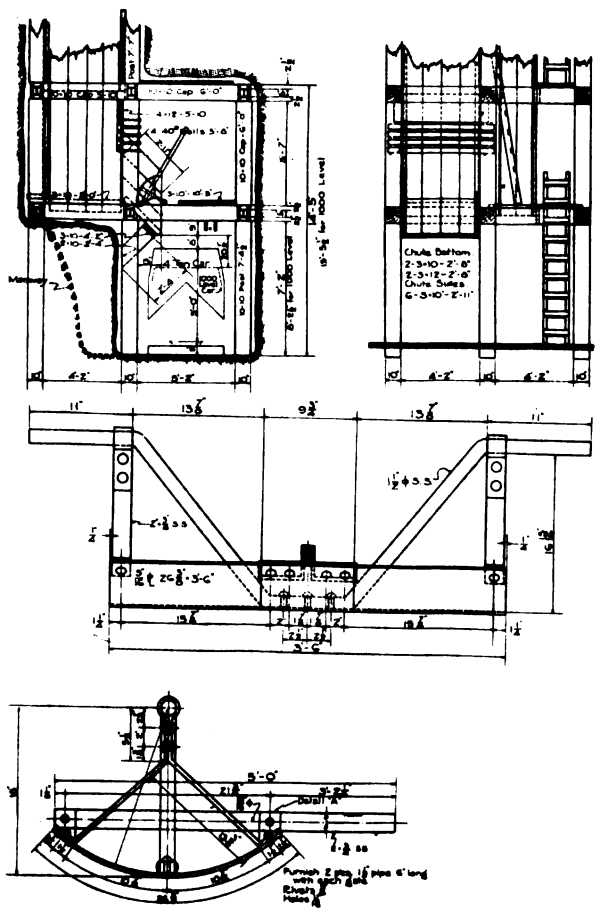

Figure 24.—Overcut-arc gate and construction details, Cananea

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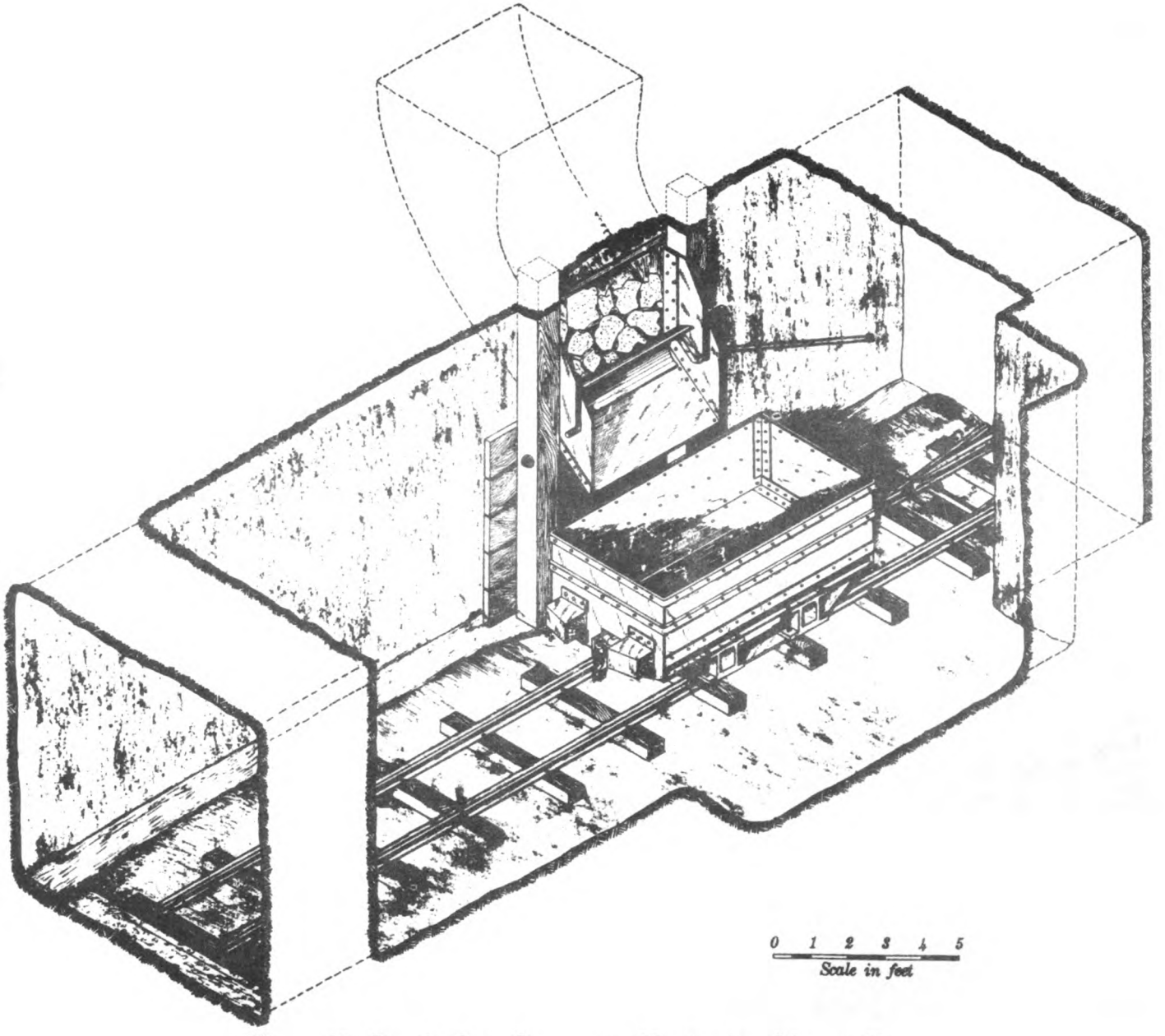

Figure 25.–Standard steel arc gate, No. 2 mine, Mascot, Tenn.

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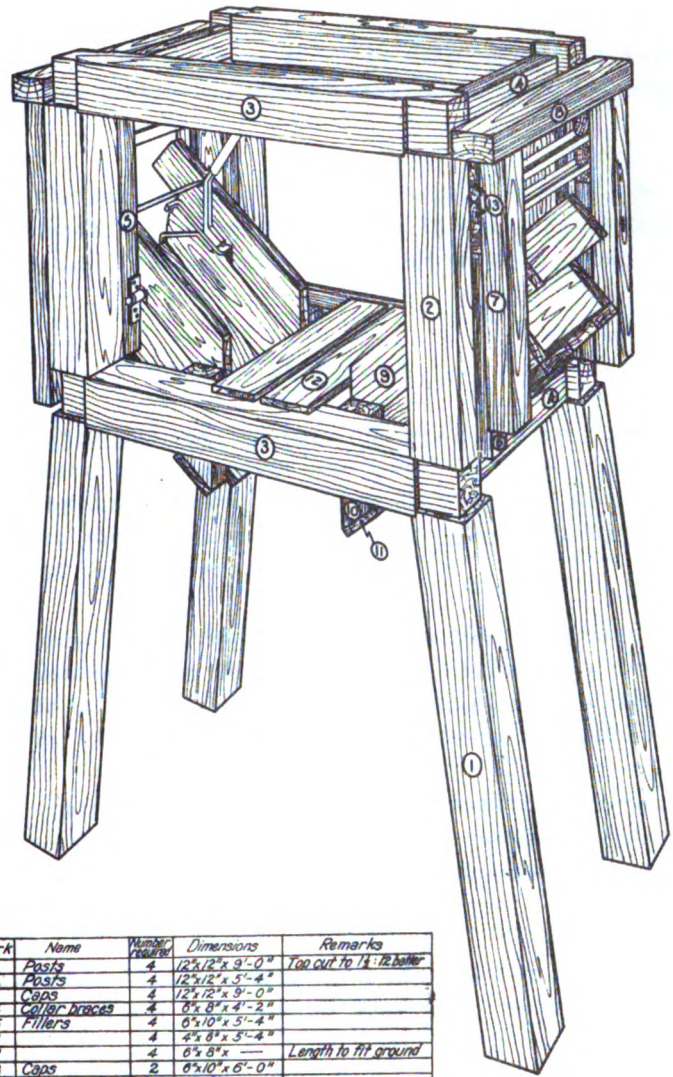

Mark	Name	Number required	Dimensions	Remarks
1	Posts	4	12"x12"x 9'-0"	Top cut to 1/4 : 12 batter
2	Posts	4	12"x12"x 5'-4"	
3	Caps	4	12"x12"x 9'-0"	
4	Collar braces	4	6"x 8"x 4'-2"	
5	Fillers	4	6"x10"x 5'-4"	
6		4	4"x 8"x 3'-4"	
7		4	6"x 8"x —	Length to fit ground
8	Caps	2	6"x10"x 6'-0"	
9	Chute sides & bottom	14	3"x12"x —	
10	Fillers	4	6"x 8"x —	
11		2	2"x12"x 4'-0"	
12	Platform	2	2"x12"x 4'-10"	
13	Filler blocks	12	4"x 6"x 6"	Shaped to fit rails

Figure 26.— Overcut-arc gate at Inspiration mine

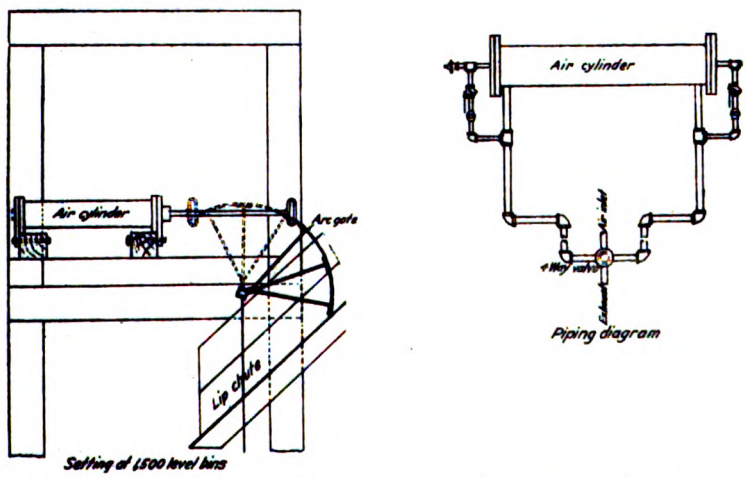

Figure 27.— Air-operated overcut-arc gate at Park Utah mine

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of gates to prevent spillage of fines. Figure 22 illustrates such a combination at the Old Dominion mine,[14] where the coarse chunks are worked through cleated stop boards and the flat door acts as the toe board.

The contraction of the gate opening shown in Figure 20 is an obvious disadvantage in drawing chunky ore. This installation is employed in chutes covered with a grizzly having rather small openings (9 inches) so that this objection does not apply in this particular case.

7.- Overcut-Arc Gates

A. (b) (1).- Convex Face Against the Ore. Overcut arc or "quarterpan" gates are so designed that the convex face bears against the ore. For use in stope chutes these gates are usually manipulated by hand levers. Figures 23, 24, 25, 26, and 27 show typical installations. Figure 24 shows construction details of a gate that has given satisfaction at Cananea both underground and on surface ore bins.

An interesting modification of the overcut arc is used at Mascot, Tenn.[15] The gate is a steel arc carried on trunions which rest in vertical slots in the steel sides of the chute (see fig. 25). This gate has been successful in handling coarse material, since large chunks may be worked through by the simple expedient of raising the gate in the slots.

Air cylinders for operation of arc gates are usually necessary only for large gates. It may be advisable to employ them on stope chutes, however, especially if the ore is sticky in character and the chutes are wide. An air-operated gate arrangement at the Park Utah mine[16] is illustrated in Figure 27.

Gates of the overcut-arc type are sometimes used as lip doors to control the flow of fines, or as check gates to control very coarse material. Such an application is shown in Figure 34.

The manner of installing overcut-arc gates materially affects the amount of effort necessary to operate them. If the center of rotation is placed at a lower elevation than the point of contact between the gate and chute bottom, as shown in Figure 39, the work of opening the gate will be materially less than if the center is high. In view of this, the installations shown in Figures 23 to 27 are all incorrectly made if ease of operation is a consideration. This principle has been observed for many years on the Mesabi iron range where thousands of gates of this type have been employed for loading soft (often sticky) fine ore. If the gate is operated by air cylinder, the observance of this principle is not so important.

B.- Undercut-Arc Gates. Arc gates of the undercut type are especially well adapted to handling large volumes of coarse, hard material. For handling material of this nature

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14 Shoemaker, A. H., Mining Methods at the Old Dominion Mine, Globe, Ariz.: Inf. Cir. 6237, Bureau of Mines, 1930, 21 pp.

15 Coy, Harley A., Mining Methods and Costs, American Zinc Co. of Tennessee, Mascot, Tenn.: Inf. Cir. 6239, Bureau of Mines, 1930, 11 pp.

16 Hewett, E. A., Mining Methods and Costs at the Park Utah Mine, Park City, Utah: Inf. Cir. 6290, Bureau of Mines, 1930, 18 pp.

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they are unexcelled for rapid loading. They can be opened and closed quickly and closing is not hindered by chunks as is often the case with overcut gztes due to lodgement of the lumps under the gate. Since the gate closes by cutting upward from below, spillage of muck on the track is reduced to a minimum.

A hand-operated, undercut-arc gate used in northern Ontario is shown in Figure 28. The gate is counterweighted to facilitate closing, and stop logs in brackets of the Keating type are provided. The gate is simple and strong, and can be installed at moderate cost. Loading with this gate is rapid and dependable. Two loaders and one locomotive engineer regularly loaded, trammed, and dumped 300 tons in 2½ hours, from five chutes of this type, the ore being very large and blocky. For operating chutes over 5 feet wide, air jacks are advantageous and economical.

An installation used at the Engels mine in California for loading at the bottom of a main ore pass is shown in Figure 29. The heavily reenforced gate is controlled by twin air cylinders with a four-way valve. An interesting adjunct to the gate is the arrangement of heavy weights hung in the chute on a horizontal shaft. They weigh 700 pounds each, being of cast iron fitted with jackets made from old roll shells to prevent breakage in chute blasting, and their use as a check gate to control large pieces of ore makes a wide chute possible. Barring out the large chunks and loosening of occasional hang-ups is consequently more easily accomplished.

An arrangement similar to the above is in use at the Alaska-Juneau mine. Figure 30 is a view of the installation. A single air jack operates the underslung-arc gate, and two more powerful ones control a check gate, of heavy steel construction, hung on a shaft between the posts of the chute set. The round steel cross pieces of the check gate are spaced about 7 inches apart to permit insertion of bars between them for loosening chunks of ore in the chute.

Installations of this general type are relatively expensive. In addition to the cost of the gates proper, added expense is often incurred because of the necessity for rather costly steel sets or concreting in heavy ground. Such elaborate arrangements are only warranted where large sustained tonnages are to be handled through the chute.

Undercut-arc gates having the convex side against the ore are not extensively used. The one shown at A in Figure 17 functions as the upper or inlet gate on a measuring pocket. It is hand-operated, the supporting arms being outside the chute and attached to the lower edge of the gate.

Another modification of this type, shown in Figure 31, was developed on the iron ranges. On account of the large amount of water in many of the chutes and a considerable proportion of chunks in the ore, the usual form of arc gate closing from the top did not operate satisfactorily. The present gate solved these difficulties, and spillage has been eliminated. A flat plate between the chute sides forms the bottom or lip apron when the gate is opened. In closing, as the gate starts to rise above the chute bottom, fine material builds up behind it and impedes the flow of ore, thus assisting in the operation of shutting the gate.

In general, undercut-arc gates are applicable to operations that call for rapid loading of large tonnages, and for handling large chunky material to which lighter and simpler gates are unsuited.

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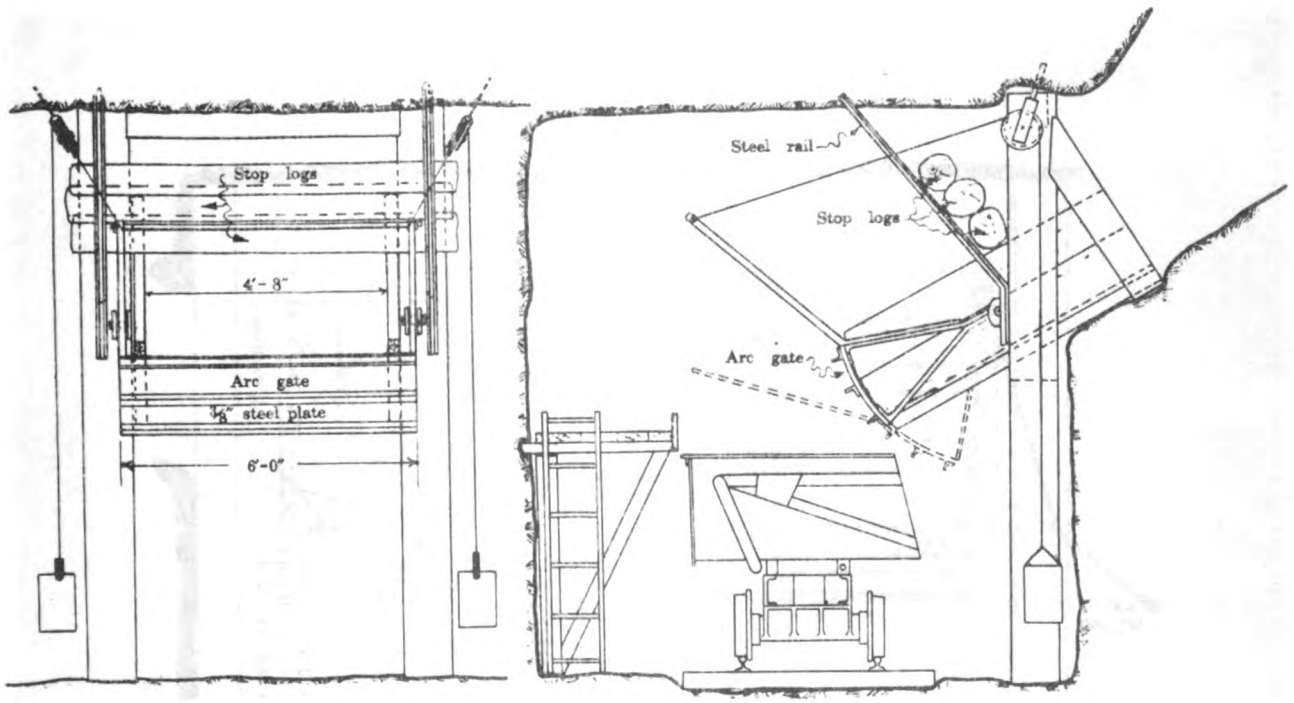
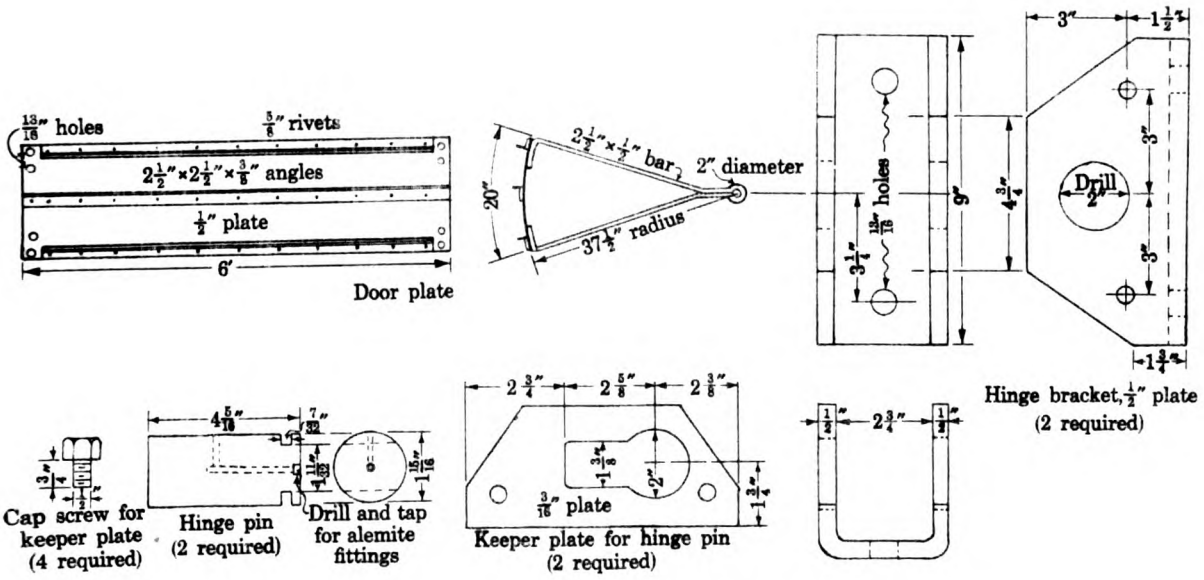


A. CHUTE ARRANGEMENT



B. DETAILS OF STEEL GATE

Figure 28.—Hand-operated, counterweighted, undercut-arc gate

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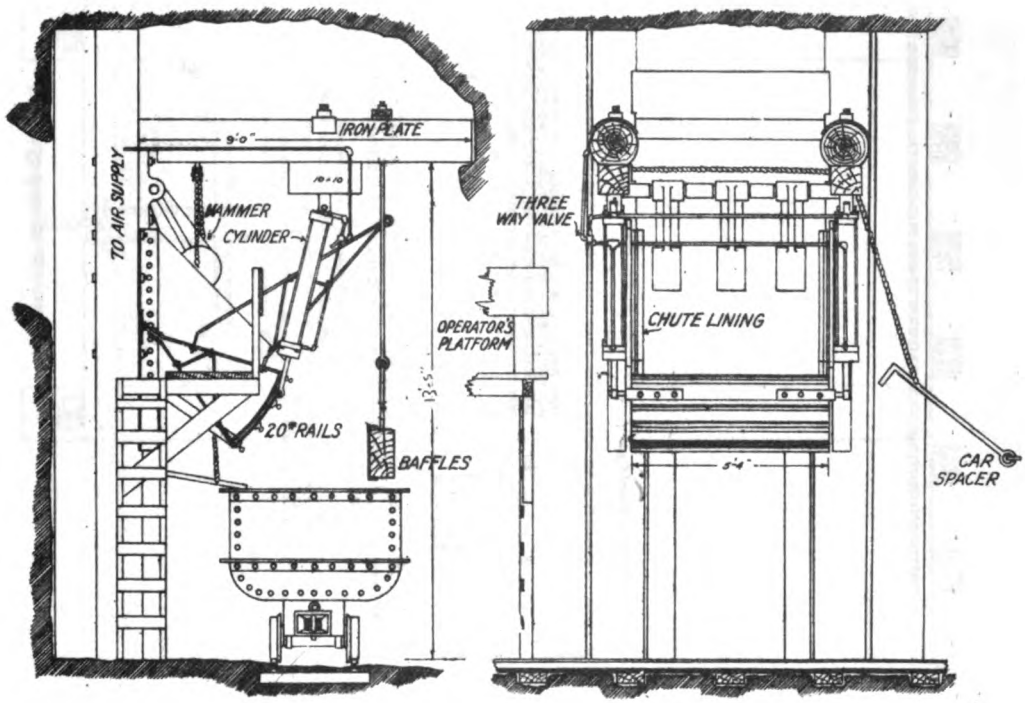

Figure 29.– Air-operated undercut-arc gate, Engels mine

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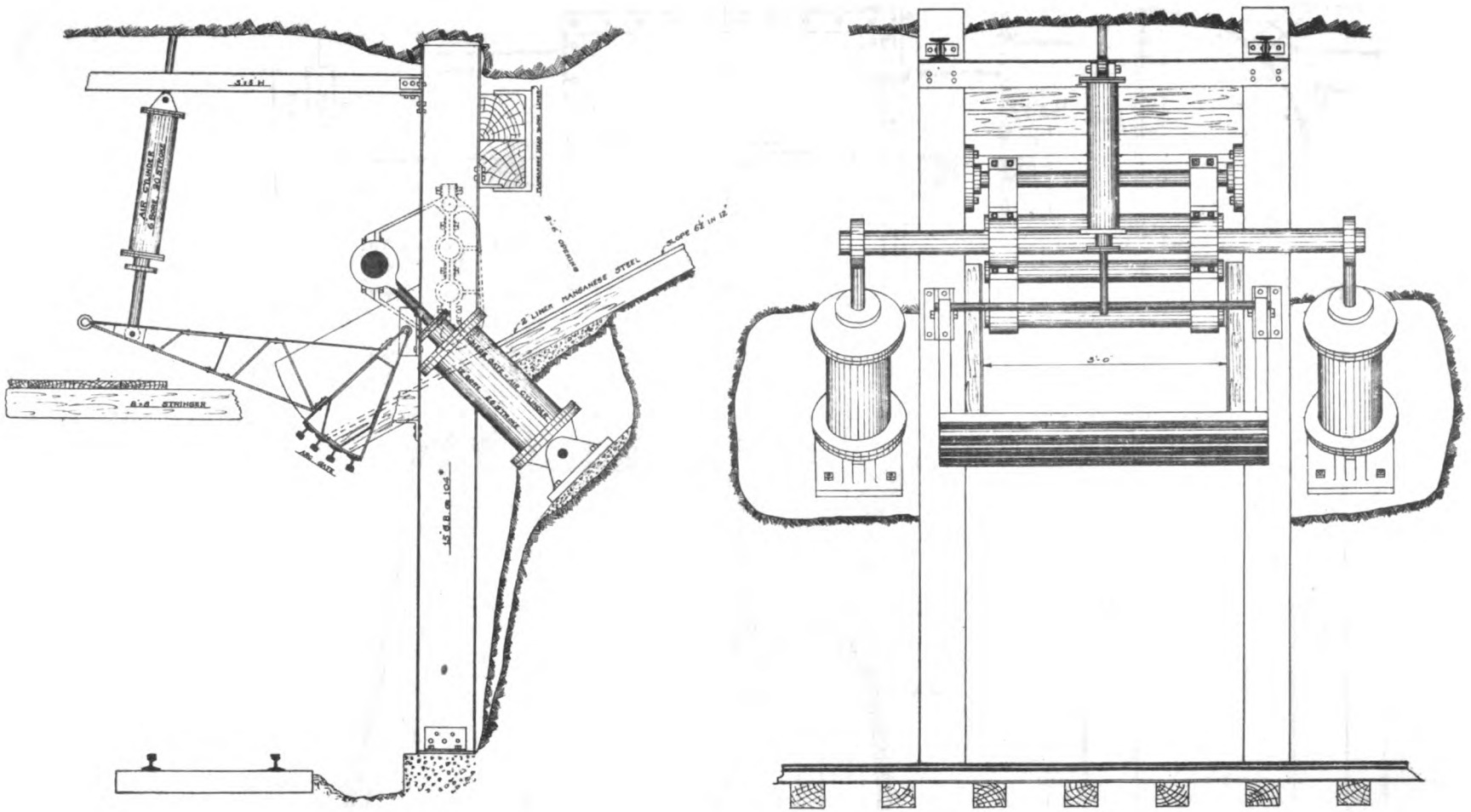

Figure 30.—Air-operated loading chute gate, Alaska Juneau mine

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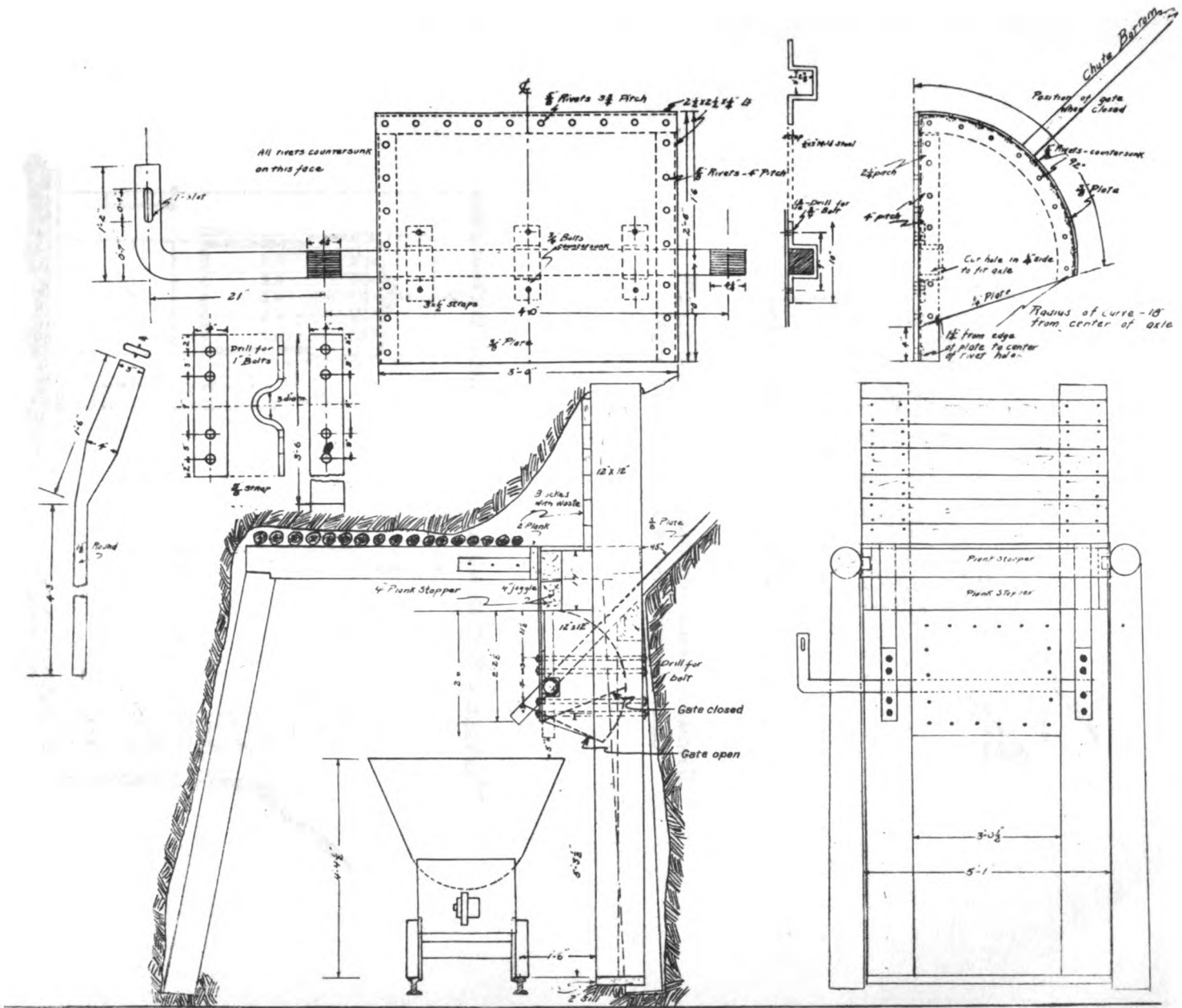
All rivets countersunk on this face
Drill for 1" Bolts
Gate closed
Gate open
Chute Bar
Position of gate when closed
Cut hole in side to fit gate
Radius of curve - 18" from center of axle
Plank Stopper
Plank Stopper

Figure 31.—Undercut-arc gate, convex face against ore, Menominee range

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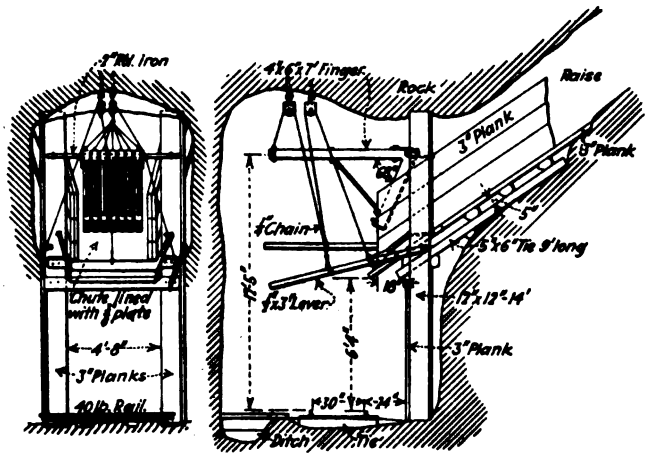

Figure 32.–Design of modified Alaska Treadwell finger chute used at a hard-iron-ore mine

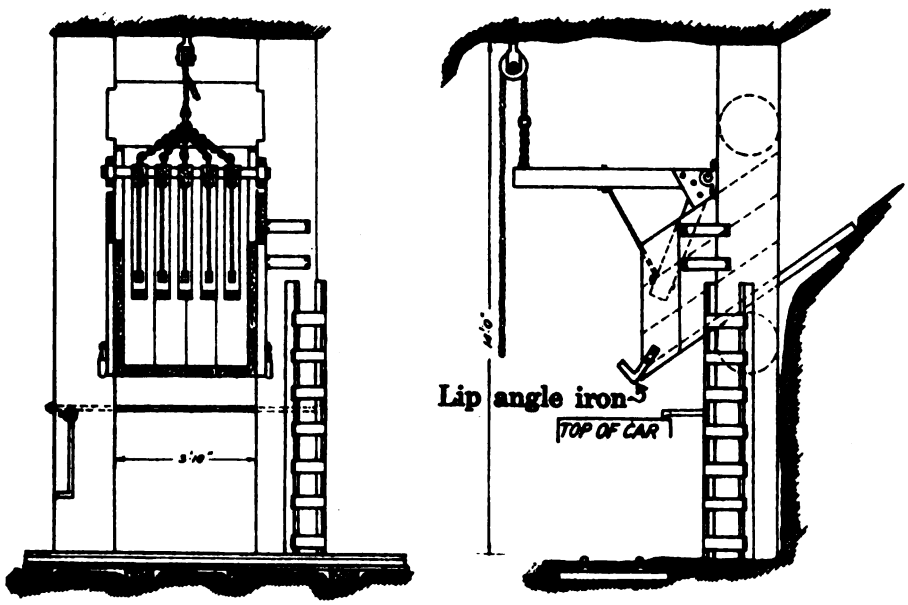

Figure 33.–Standard finger chute, Engels mine

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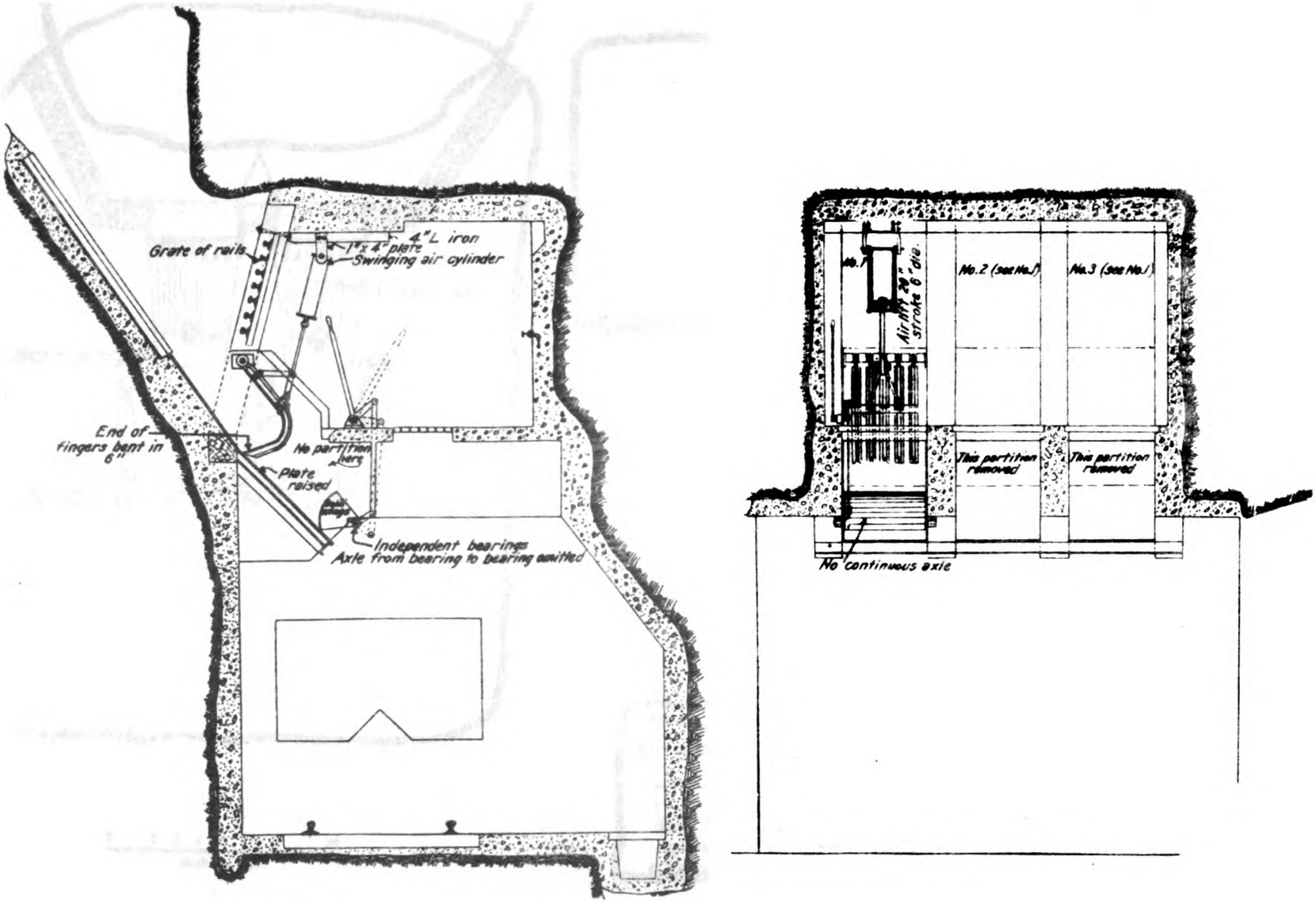

Figure 34.–Finger gates, main ore pocket, United Verde Extension mine

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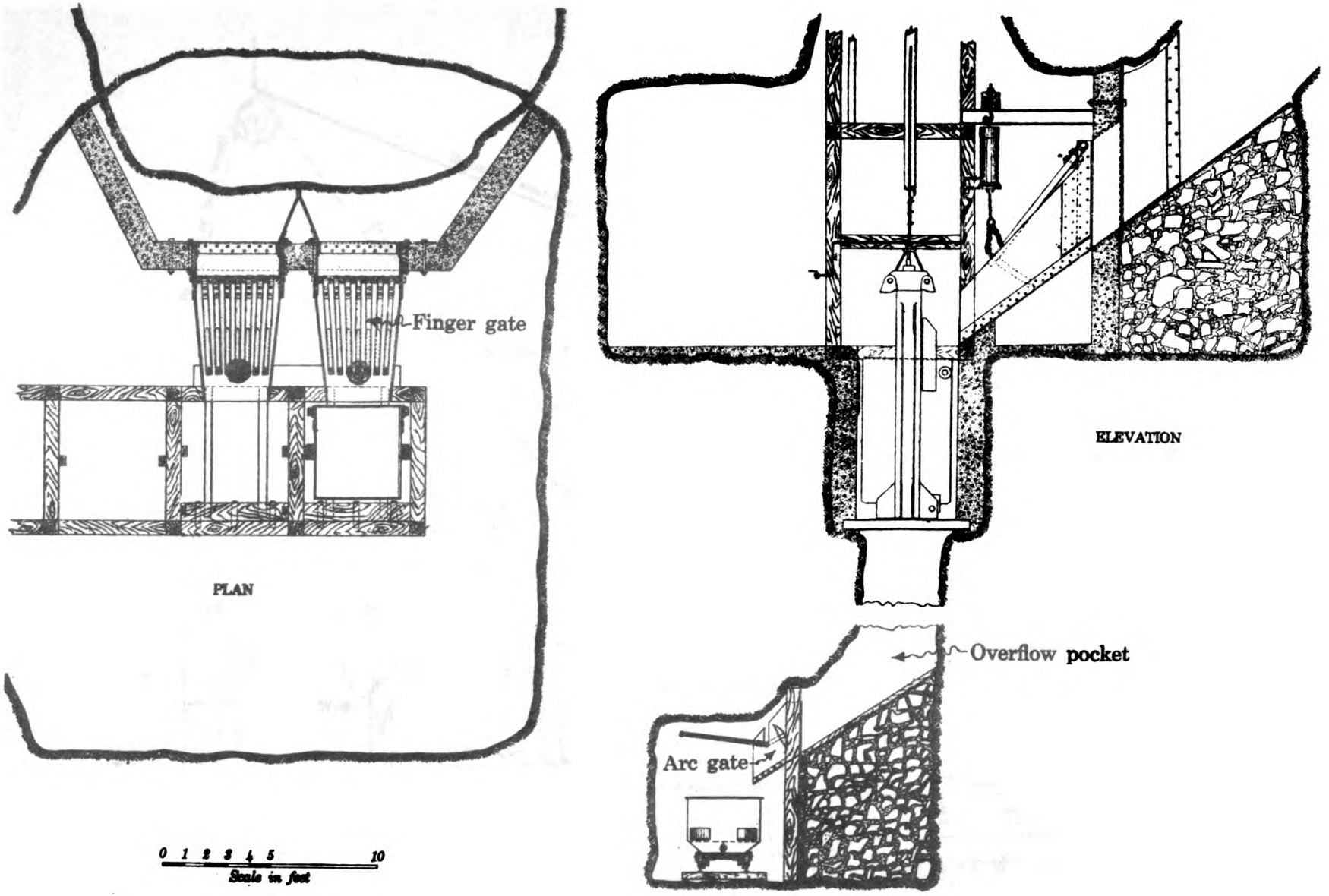

Figure 35.- Air-actuated finger gate, No. 2 mine, Mascot, Tenn.

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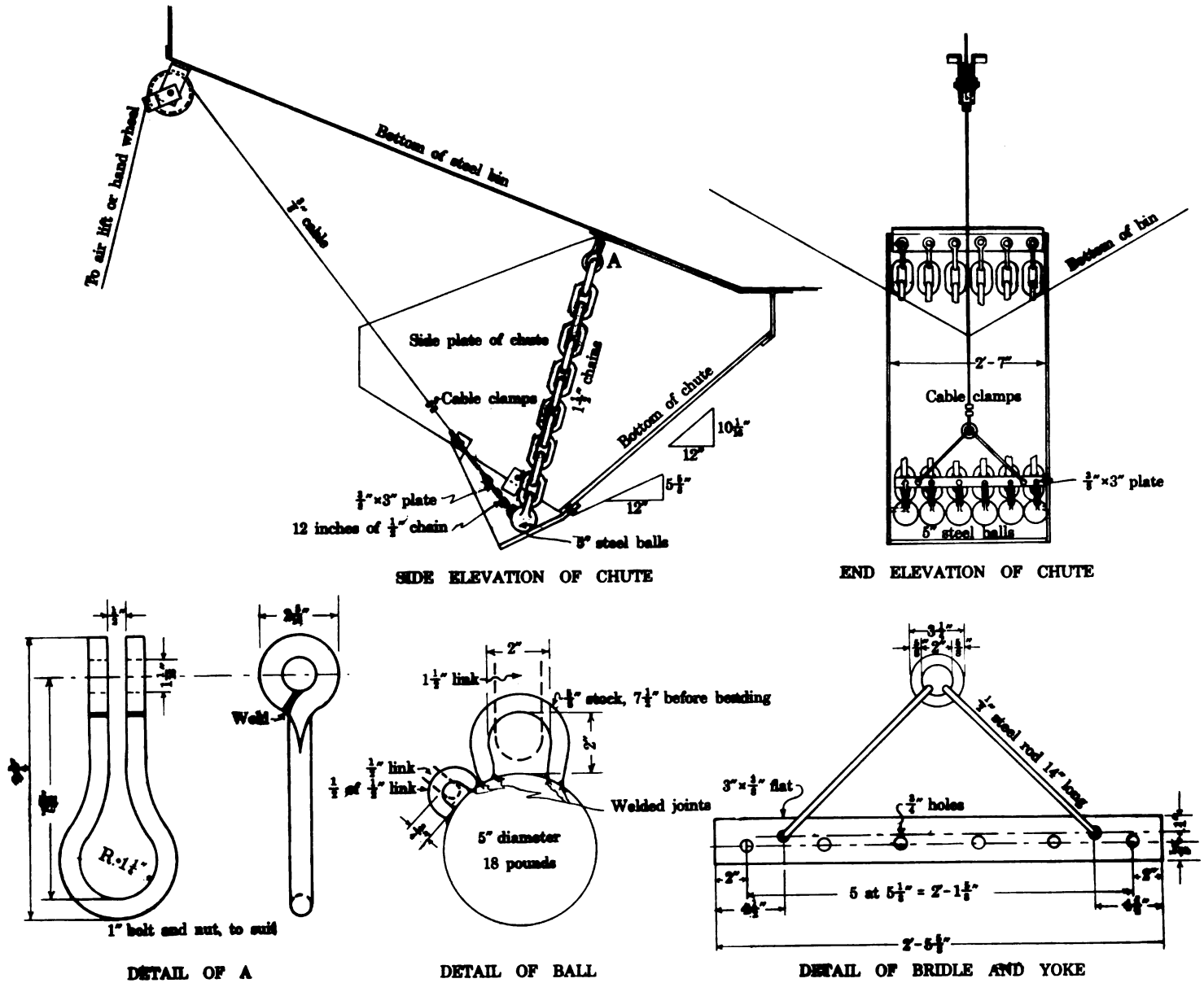

Figure 36.—Ball and chain door for ore chutes

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8.- Finger Gates

The finger gate (figs. 32, 33, 34, 35) consists of a number of arms or fingers suspended individually on a horizontal shaft above the chute, each finger being free to move independently of the others. There are two different types of this gate, one illustrated by Figures 32 and 33, and the other by Figures 34 and 35. The former is the old Alaska-Treadwell gate having the fingers pivoted at the knuckle, the weight of the long joint of the finger serving to close the door (formed by the short joint). In the other type the position of the fingers is just reversed, and they drop down under their own weight like a claw, to close in a manner similar to an overcut arc with the concave side against the ore stream.

Lumps catching beneath or behind one or two fingers do not prevent the closing of the others and may be quickly freed by raising the particular fingers involved. Leakage of fines between the fingers and resultant spillage after closing the gate is usually prevented by a toe board placed on iron lip angles (fig. 33).

The Alaska-Treadwell gate is employed at the Engels mine in California[17] for loading Cars in haulage drifts and for loading skips as well. Detail costs of installation at Engels mine are given on page 21. The gate is of steel reenforced timber construction and is hand-operated.

A modification of the Alaska-Treadwell type, illustrated by Figure 32, is used at a hard-ore mine in Michigan with success. In this case a toe board is counterbalanced with the fingers and is raised as they are lowered.

More elaborate installations designed for heavier duty than those just described are air-operated and of steel construction throughout. A gate of this class at the United Verde Extension is shown in Figure 34. A small hand-operated overcut-arc gate on the lip of the chute stops spillage of ore. Figure 35 represents an installation at Mascot, Tenn., where air-actuated finger gates are used without measuring hoppers to load skips. Spillage falls into a pocket at the shaft bottom where it is loaded into a car through a small hand-operated overcut-arc gate. The ore breaks very coarse and little fines are produced which would pass between the fingers.

Finger gates are suitable for handling coarse, dry ore. Their chief advantages are rapid loading of large tonnages and feasibility of working big chunks through the gate without a rush of finer material. They are relatively high in cost, especially the more elaborate steel, air-operated modifications, and their use is justified only when they handle heavy tonnages. They are cumbersome and require, together with their operating mechanism, considerable space for installing.

9.- Curtain or Flexible Door Type

Ball and Chain Door for Ore Chutes. The accompanying illustration (fig. 36) shows a typical installation of the ball and chain door as devised and installed by D. L. Cramp, mechanical superintendent of Lake Shore Mines, Ltd., Kirkland Lake, Ontario.

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17 Nelson, W. I., Mining Methods and Costs at the Engels Mine, Plumas County, Calif.: Inf. Cir. 6260, Bureau of Mines, 1930, pp. 9-11.

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This type of gate or door has proved its adaptability to both fine and chunky ore, combining the advantages of the finger chute with simplicity and sturdiness of construction, and requires very little room for its installation.

The door was first installed at the Lake Shore mine at a loading chute in the surface waste bin, which is a steel hopper located at No. 3 shaft. Its operation was so satisfactory and the wear so light, that similar doors have been installed underground, at the bottom of a 200-foot ore pass and above the ore pocket feeding the crusher on the 2,000 level, just above the crusher for feeding ore into the crusher from the pocket just mentioned, for loading cars from the rock bin at the top of the 2,000 level winze, and for filling skip measuring pockets from the ore passes below the crusher.

In operation, the chains wrap themselves around lumps of ore, the balls at the same time holding back the fines so that there is no spillage when the door is dropped. The door is made of 1½-inch diameter chains with 5-inch steel balls welded to the bottom ends, forming a heavy curtain, the weight of which holds back the ore or rock in the chute. The balls are attached by ½-inch chains to a yoke or flat plate which is in turn connected by bridle rods to the operating cable.

To open the door, the bottom is raised or furled up by means of the cable which may be operated by hand, by compressed-air piston, or by winding on a drum operated by a hand wheel. All three methods are employed in the different installations at the Lake Shore mine. Direct pull by hand is used at the surface rock bin and for loading mine cars at the 2,000 winze bin. Air cylinders are employed at the 2,000 ore pass and crusher, and hand wheels are used at the skip measuring pockets.

At each installation, dropping the curtain immediately stops the flow of ore or rock. The short ½-inch chains connecting the balls to the yoke permit differential movement of the curtain chains and balls for the removal of chunks without an attendant rush of fines.

The present installations have been made up from 1½-inch steam shovel dipper chain and 5-inch ball-mill balls. This chain is expensive, and ordinary chain costing considerably less will be used for future installations. A rather flat chute bottom is desirable, but one door is operating satisfactorily on chute having a 45° slope.

The illustration shows general views of the first installation at this mine and some details of construction. The writer's observation of the operation of the several installations is convincing as to the quick and positive action and practicability of this type of door for loading cars and measuring pockets and for feeding crushers and, indeed, for general purposes where chutes are installed permanently or semi-permanently.

Where chute blasting is necessary, this door has a decided advantage in that blasting will not injure it. The chute can be "poked" by inserting a bar between the chains without raising the door, which is another advantage. It is also easily installed and if repairs or replacements become necessary they may be quickly and easily accomplished.

The advantages of this door and its field of usefulness will readily be appreciated by operators, particularly where a mixture of chunky and fine rock must be handled through chutes.

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Auxiliary Doors

A large number of auxiliary devices have been devised to increase the efficiency and safety of chute-gate operations and some of the gate types described in this paper are used on chute installations in an auxiliary capacity. Several of these applications have been described in connection with the individual types. In general, auxiliary gates are placed either in the chute above the main door for the purpose of serving as check gates to control coarse material or are installed at the chute mouth as toe boards and lip aprons to prevent leakage or overflow of fines.

Baffle Doors. The use of baffle doors on ore chutes is rather rare. Figure 18 shows a front discharge lever-operated door employed in this capacity in conjunction with a bottom-discharge hinged gate. It aids in directing the ore stream and can be used in part to control the volume of discharge. Heavy curtains of chains are sometimes resorted to in order to prevent damage to chute timbers. Often they are hung near the collar of the chute or ore pass, as at Cananea where scrapers move coarse ore direct into chutes, but they are also used to take the impact of falling ore at chute bottoms.

Check Logs and Hammers. A similar device for checking he fall of large pieces in inclined chutes before they strike the chute-gate consists of a stull near the hanging wall side of the raise to which the ends of short logs are attached by pieces of chain or old cable. The other ends of the logs rest loosely against the chute bottom. The logs, being free at one end, do not prevent the passage of broken material, but by their inertia serve to absorb some of the force of heavy falling chunks.

Check hammers are used on chute gates to control large pieces. The installation at the Engels mine has been described on page 10 (see fig. 29).

Other types of gates are often used as checks. The commonest ones have been already described, and include stop-logs, extra stop boards, and overcut-arc gates (used at Fierro, N. Mex.)[18].

Lip aprons and toe boards to minimize the leakage and overflow of fines generally consist of a stop-board in brackets (fig. 33), a flat overcut gate (fig. 21), an overcut arc (fig. 34), or a hinged lip apron (figs. 9, 10, 12, and 13). These types have all been discussed.

Stop-logs have been described, and are illustrated in Figures 7, 8, and 28.

COSTS OF ORE-CHUTE GATES

Costs of a number of different standard types of gates installed at various mines in the United States, Canada, and Mexico are appended hereto.

These costs have been furnished through the courtesy of the managements of the mining companies. In some instances it was possible to give very complete costs, including rock excavation, lumber, steel, and labor of installing the gates. Some operators furnished

18 Kniffin, L. M., Mining and Engineering Methods and Costs of the Hanover Bessemer Iron and Copper Co., Fierro, New Mexico, Information Circular 6361, U. S. Bureau of Mines, 1930, 21 pp.

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only the costs of the gate proper, installed complete, while others included the supporting timbers. The reader will be able to gather from the tabulated costs in each case just what details are included in the total costs.

Since the wage rates, timber, and steel costs vary considerably at different mines from which the data were secured, and since the items of cost included by the different companies furnishing the figures differ, it is obvious that direct comparisons of costs at the several mines for different types of chutes can not be made.

Platform Chutes

The following figures cover the present cost of an improved form of the platform and grizzly shown in Figure 2. The loading opening or "eye" is protected by a heavy iron casting overhanging the opening. The cost given is an average of several installations and does not include rock work. This installation is at Ducktown, Tenn.

4 - 10-inch 25.4-pound I beams, 7 feet 8 inches long with 4 - 6 by 4 by 3/8 by 5 1/2 inch angles at $8.64 including fabrication	$34.56	
4 - 10-inch 25.4-pound I beams, 2 feet 8 inches long at $3.36 including cutting and drilling	13.44	
Total steel		$ 48.00
2 - 900-pound reinforced cast-iron grizzly eyes at $30		60.00
14 - 6 by 8 inch by 6 foot oak posts; 336 feet at $36 per M	12.10	
2 - 8 by 10 inch by 20 foot oak caps; 268 feet at $36 per M	9.65	
7 - 8 by 10 inch by 5 foot oak caps; 238 feet at $36 per M	8.56	
100 square feet 2-inch oak flooring; 200 feet at $26 per M	5.20	
Total lumber		35.51
Total labor, installing		80.46
Total cost		223.97

Stop-Board Chutes

A simple type of stop-board bracketed chute used at the Ahmeek mine in the Michigan copper district is shown in Figure 7-A. This chute employs small green saplings for stops. The cost is as follows:

Oak boards and timber	$ 5.00
Labor installing, contracted at $11 per chute, including cutting hitches and erecting posts. Irons, no cost given; bolts and rails used over and over again	11.00
Total	$16.00

Hollinger Chute. The cost of the Hollinger chute (fig. 8) as installed in northern Ontario is given approximately as follows:

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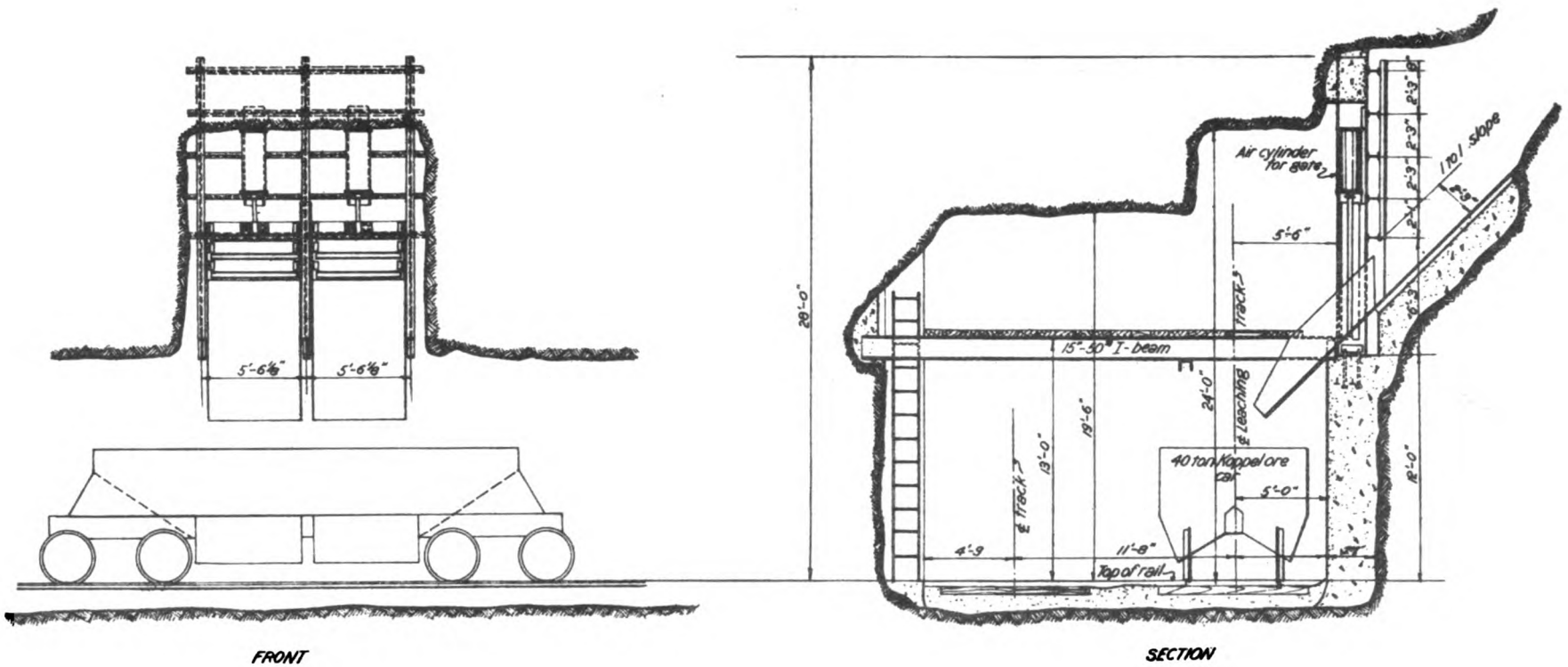

Figure 37.- Hopewell tunnel loading bins

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Labor	$13.75
Material	35.25
Transportation	3.50
Total	52.50

The salvage value of this chute is $22.

A similar chute, differing slightly in detail and without the semicircular angle-iron collar is employed for drawing ore from shrinkage stopes at the Lake Shore mine, Kirkland Lake, Ontario.

The cost is given as follows:

Labor, underground	$18.00
Labor, surface (bending rails, threading U bolts, etc.)	4.00
Ttal labor	22.00
Cost of material, timber, etc.	23 00
Total cost	45.00

Cleated Stop-Board Gate, Negaunee, Mich.

Iron work	$ 8.80
Lumber	20.00
Labor	13.30
Total	$42.10

Cost does not include raising, drift sets and supports for raise cribbing.

Overcut Sliding Gate

Figure 37 shows twin gates of this type operated by air cylinders at the Hopewell tunnel ore bins of the United Verde Copper Co. The cost of these gates and bin is given as follows:

Cutting out	
Mining and mucking labor	$ 240.00
Explosives	122.00
Timber installation	
Labor	90.00
Material	100.00
Steel installation	
Labor	1,026.00
Material (not including air cylinders)	930.00
Total cost	$2,508.00

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Installation costs of the chute and air-operated guillotine gate used at Mineville, N. Y., and illustrated in Figure 14-a, are itemized in the following estimate:

Estimate of pocket cost

Pocket-front raise:			
Material		$ 66.40	
Labor		224.00	
Total		290.40	
Pocket-neck raise:			
Labor		230.00	
Supplies		63.80	
Total		293.80	
Chambering:			
Labor		535.80	
Supplies		150 00	
Total		685.80	
Pocket front:			
Labor		195.16	
Supplies:			
Timber	$370.13		
Bolts, plugs and nails	52.44		
Angle iron and straps	247.30		
Two - 4-foot pocket gates	112.20		
Two - 4-foot air lifts	204.00	986.07	
Total		1,181.23	
			$2,451.23
Fifteen per cent engineering and contingencies			367.67
Grand total			$2,818.91

Hinged Lip-Apron Gate

The cost of the Baltic gate (fig. 16) is estimated by the chief engineer of the Copper Range Co. as follows:

Apron — labor and material	$16.25
Preparing wall and installing	7.54
Total	23.79

Arc-Type Gates

1. Overcut Gate -- Flat Door

Figures 21 and 22 show gates of this type as installed at the Magma and Old Dominion mines, respectively. Figure 38 shows a similar gate employed at the United Verde Extension mine. The cost of the Old Dominion gate is given as follows:

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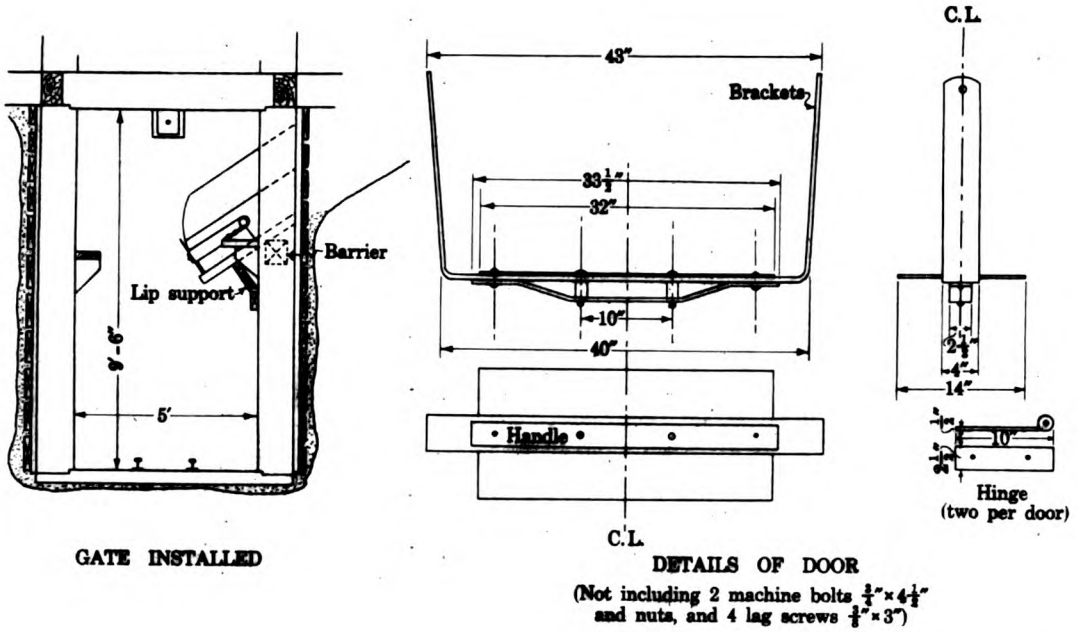

Figure 38.—Chute door, United Verde Extension mine

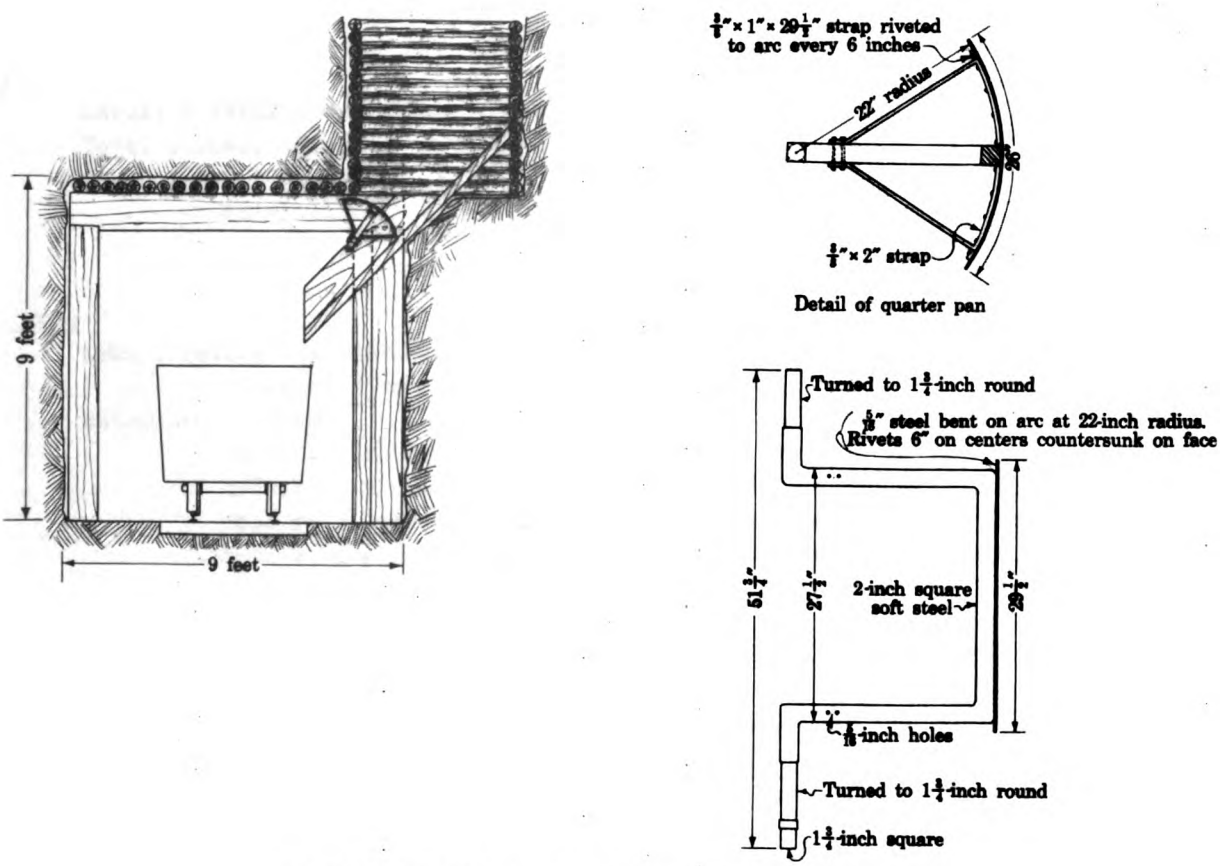

Figure 39.—Standard chute and gate, Mesabi range

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Material	
200 feet of lumber	?
Iron door	$ 3.75
Lag screws	.20
Labor	3.50
Delivery of material	1.00

A more detailed cost is given for a similar 4-post chute used at the United Verde mine as follows:

Cutting out	
Mining and mucking, labor	$ 50.00
Explosives	20.00
Timber installation	
Labor	35.00
Material	42.00
Total, installed complete	147.00

Cost of Chutes at the United Verde Extension Mine, Jerome, Ariz. (fig. 38)

Chute

Labor; framing and partial assembly of material	$2.08
Total lumber, 162.4 board feet at $29.00 M	4.70
Five pounds 60d nails at $0.05	.25
Material cost of chute	4.95

Chute Door

Labor, making and assembling	
Blacksmith and helper, 1 hour at $1.16	$1.16
Material (itemized)	
Door, 1 piece 14 by 32 by ¼ inch boiler plate, weight 31 pounds	
Brackets, 1 piece ¼ by 3 by 86 inch strap iron, weight 36 pounds	
Handle, 1 piece ¼ by 3 by 40 inch strap iron, weight 8 pounds	
Hinges, 2 pieces ¼ by 2½ by 12 inch strap iron, weight 8 pounds	
Total weight	83 pounds
83 pounds of boiler plate and strap iron at $0.035	$2.90
1 pound ¾ by 3 inch rivets at $0.03	.03
2¾ by 5½ inch machine bolts at $6.00 per 100	.12
Total material cost (door)	3.05

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Cost of installation (underground)	
Miner and helper, 4 hours at $1.175	$4.70

Summary

Chute, labor, framing and partial assembly	2.08
Supplies (lumber, etc.)	4.95
Chute door, labor, making and assembling	1.16
Supplies (boiler plate, etc.)	3.05
Total cost of complete chute	11.24
Labor, installing (mine)	4.70
Total cost of making and installing complete chute	15.90

Costs for the same type of gate installed complete at the Lake Shore mine, Kirkland Lake, Ontario, is given as follows:

Labor, underground (installing gate only)	$10.00
Labor, surface shop	6.25
Total labor	16.25
Cost of material (doors, plate, sides, bottom, head block, etc.)	15.00
Total labor and material	31.25

2. Overcut Arc Gates — Curved Door

(a) Standard chutes for mine-car loading at Inspiration mine, Inspiration, Ariz. (figs. 23 and 26).

Timber	$ 9.12
Steel, including door	15.64
Labor, installing	8.50
Total (for chutes of all new material), each	33.26

The steel can be salvaged and used a number of times. It can be taken that the average cost of chutes installed, of new and old material is not over:

Timber	$ 9.12
Salvaging steel	2.50
Labor, installing	8.50
Total, each	20.12

(b) Standard ore chute at La Colorada mine, Cananea, Mexico (fig. 24).

Figures include cost of raise to top of pony set, 14 feet above rail. The raise is driven and timbered on contract, 5 feet being allowed for pony set, measurement from the

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rail. Contractor furnishes labor and explosives and is paid 10 pesos a foot for this work and 15 pesos for completing the chute. Costs in United States currency are:

Timber for raise (framed), 1,842 board feet at $37	$ 68.15
Timber for chute (framed), 100 board feet at $37	3.70
Contract price, 19 feet at $4.17 (10 pesos)	79.23
Extra for chute (15 pesos)	6.25
Rails (salvaged) at $0.01 per pound	2.95
Bolts, nails, and lag screws	6.91
Steel gate complete	25.13
Total cost of chute and gate	$192.32

(c) The arc-type gate used for loading hard chunky ore from mill holes into mine cars at the American Zinc Co. property at Mascot, Tenn. (fig. 25).

The cost of the complete installation is $110, as detailed below.

Shop

Plates		
½ by 50 by 48 inch = 17 feet at $0.67 per square foot	$11.39	
⅜ by 48 by 108 inch = 36 square feet at $0.354 per square foot	12.74	$ 24.13
Angle Iron		
½ by 3 by 3 inch by 6 foot at $0.30 per foot	1.80	
⅜ by 6 by 6 inch by 11 foot at $0.885 per foot	9.74	11.54
Flat Soft Steel		
1 by 3 by 18 inch at $0.25 per foot	.38	
2 by 2 inch by 8 foot at $0.46 per foot	3.68	4.06
Rivets		
25 pounds, ¾ by 2 inch at $0.06 per pound	1.50	
10 pounds, ½ by 4 inch at $0.05 per pound	.50	2.00
Bolts		
14 - ¾ by 2 inch machine bolts at $0.042 each	.59	.59
Labor		
25 hours at $0.60 per hour	15.00	15.00
Power, etc.	2.68	2.68
Total shop		$ 60.00

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Underground

Timber		
2 - 10 by 10 inch by 12 foot at $3.50 each	$ 7.00	
1 - 8 by 8 inch by 12 foot at $2.24 each	2.24	
1 - 4 by 8 inch by 12 foot at $1.12 each	1.12	
6 - 2 by 12 inch by 12 foot at $0.84 each	5.04	
4 - 3 by 12 inch by 12 foot at $1.26 each	5.04	20.44
Labor		
2 - Shifts cutting hitches at $3.42 per shift	6.84	
2 - Shifts installing chute at $3.42 per shift	6.84	
1 - Shift cutting out brow at $3.42 per shift	3.42	17.10
Explosives, hauling, etc.	12.46	12.46
Total underground		$ 50.00
Total shop and underground		$110.00

(d) An arc-type or "quarter-pan" gate shown in Figure 39 is employed extensively on the Mesabi iron range for loading soft iron ore from chutes into mine cars. The cost of the chute gate proper is approximately $35. The gate is used over and over again, being transferred from one chute to another.

(e) The air-operated arc gate employed at the Park-Utah mine as illustrated in Figure 27 is estimated by E. A. Hewitt, chief engineer, to cost:

Materials	$ 30.00
Labor	85.00
Total	115.00

Underslung-Arc Gate

Figure 28 shows a counterweighted underslung-arc gate employed for loading hard, chunky ore. A large jaw crusher was installed underground so that it was unnecessary to break the ore fine in the stopes, and very large chunks were drawn through this type of chute. The material cost of iron and steel which was purchased fabricated and ready for installation from a steel manufacturing concern was $65.

Undercut-Arc Gate, Convex Side to Ore

Figure 31 shows a gate of this type employed at a mine on the Menominee Range in Michigan. The approximate cost of this gate, with the miscellaneous iron hangers and bolts, is $70.

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(f) Overcut Arc Gate — Negaunee, Mich.

Iron work	$36.90
Lumber	12.50
Labor	14.15
	$63.55

Cost does not include raising, drift sets and supports for raise cribbing.

Finger Chute Gates

Figure 33 shows the standard finger chute gates installed at the Engels mine in California. Detailed costs are given below.

Labor and material cost of excavating a chute raise and station:

	Labor	Material	Total
Miner, 10 shifts	$50.00	-	$ 50.00
Mucker, 10 shifts	45.00	-	45.00
Explosives	-	$36.63	36.63
Totals	$95.00	$36.63	$131.63

All chutes for the stopes are equipped with finger-type gates, and each chute has an opening 3 feet wide and 2 feet high when the fingers are fully raised (fig. 33). The labor and material required and the cost of installing a stope chute with finger gate are as follows:

	Labor	Material	Total
Iron lining and brace	$ 3.44	$ 6.75	$ 10.19
Lumber	4.29	3.75	8.04
Chain	1.37	.96	2.33
Eyebolt	.52	.30	.82
Sheave	1.72	scrap	1.72
Shaft 2-11/16 inches by 6-1/2 feet	-	8.78	8.78
Shaft housing	2.03	2.65	4.68
Shaft housing bolts	-	1.00	1.00
Two shaft collars and 4 washers	1.37	scrap	1.37
40 feet round timber at 8¾ cents per foot	-	3.50	3.50
60 feet round timber at 6 cents per foot	-	3.60	3.60
384 bd.ft. 4 by 12 inch timber at $25 per M	-	9.60	9.60
3/16-inch steel for bottom	-	6.40	6.40
3/16-inch sheet steel for cap and sides	-	6.91	6.91
Rod 3/4-inch by 8 feet	.34	.60	.94
Cap hooks	.69	scrap	.69
Stop board	.69	-	.69
15 feet 3/4-inch rope	-	.53	.53
Labor building chute, timberman and helper	70.00	-	70.00
Caps and powder for hitches	-	2.00	2.00
Totals	$86.46	$57.33	$143.79

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Curtain Type Gate

Figure 40 shows a chain-and-ball gate installed on the 1800-level of the Lake Shore mine, Kirkland Lake, Ontario. This gate is used for drawing ore from the main ore pass connecting the 1600 and 1800 leve.s (200 feet vertical interval).

The cost of this gate, installed in January, 1931, was as follows:

Material (including block and tackle for lifting)	$127.00
Labor (making)	32.00
Labor (installing)	13.00
Total cost	$172.00

Cost does not include cutting raise or the 10" H-beam cap piece.

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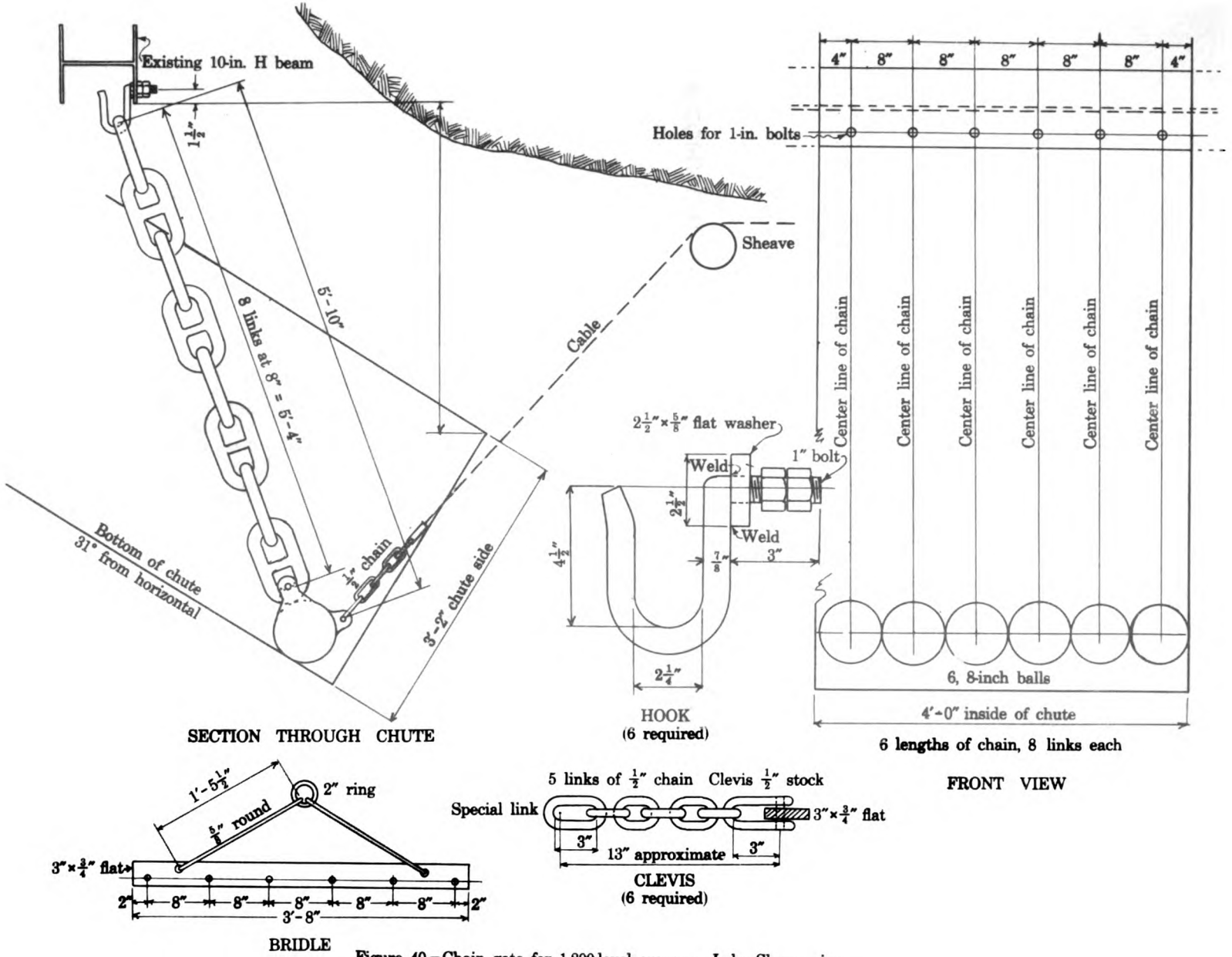

Figure 40.—Chain gate for 1,800-level ore pass, Lake Shore mine

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